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VOLUME 4, No. 4 APRIL 1952

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WORLD CROPS

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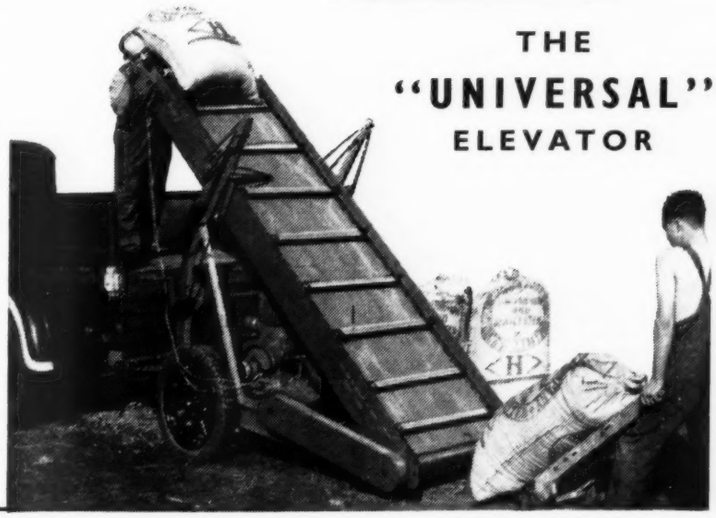

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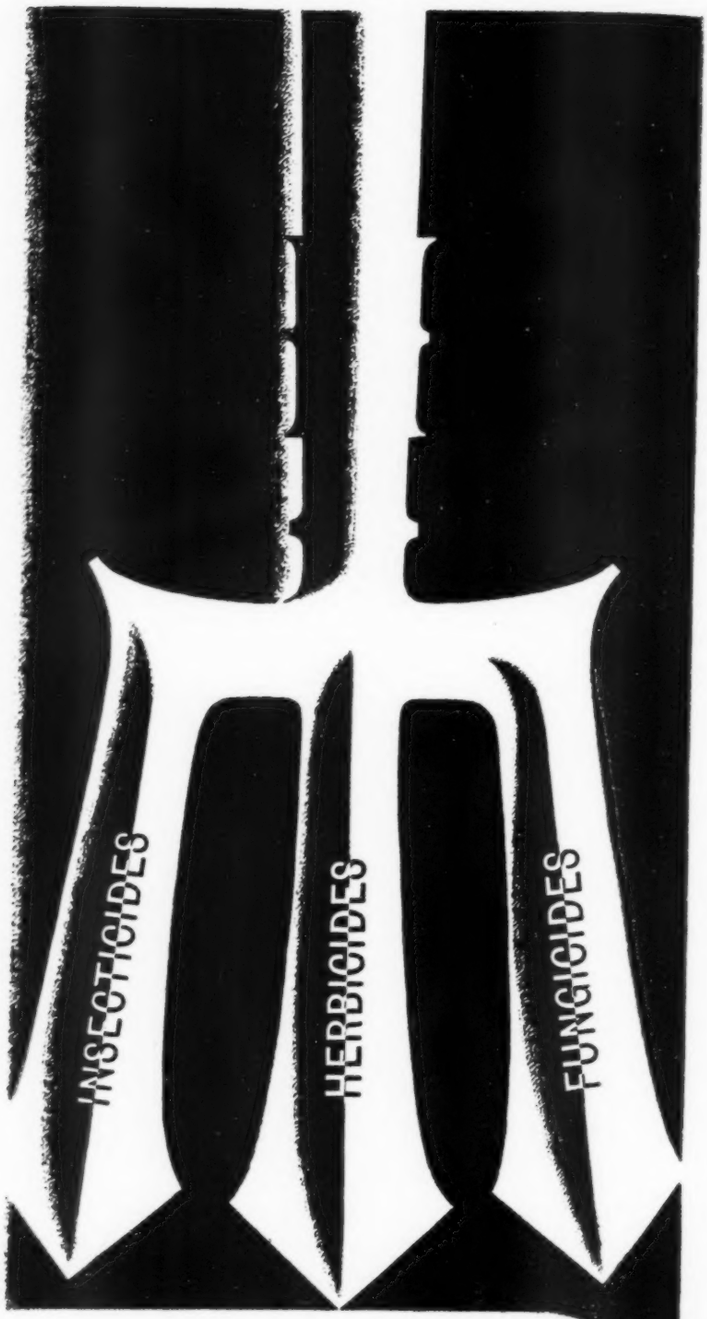

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Editorial Comment

Rotavation and rice

ON another page of this issue we publish an article on rotary cultivation as part of our present series under the general title of ' Industry's Contribution to Agricultural Research,' while elsewhere there are other articles dealing with various aspects of rice growing. Point is given to the latter by the forthcoming meeting of the International Rice Commission under the auspices of FAO at Bandoeng in Java next May.

We commented on this last month and incidentally expressed some surprise that in the agenda for the conference the subject of mechanisation of rice growing does not appear.

In this latter connection the rapidly extending application of rotary cultivation in rice growing is to our mind a specially interesting development which requires more than passing attention.

In preparing land for rice planting the object is precisely the reverse of that aimed at in the preparation of land for the majority of other arable crops. The vast bulk of the world's rice is grown submerged by a shallow layer of water during the greater part of its life, and the object of preliminary cultivation is to produce a layer of soil in which the soil aggregates have been completely broken down to provide a top layer of submerged soil which is completely disaggregated and which forms the medium for the growth of the crop. This is underlain by a more or less puddled layer of soil which helps to retain the water on the land.

Dry and wet crops

WITH dry crops, on the other hand, the object of preliminary cultivation is to open up the soil and at the same time avoid so far as possible breaking up soil aggregates and the formation of a ploughpan. On this account it is important to carry out preparation at the correct moisture point, neither too wet nor too dry.

In rice cultivation it is difficult to imagine a more efficient way of securing the necessary degree of disaggregation than by the help of a machine with rotating blades which traverses the wet fields. In traditional native rice cultivation the same result is secured by the repeated trampling of the fields by teams of buffaloes or oxen driven round and round in circles or by the repeated passage of ploughs or other implements. The rotary cultivator seems capable of performing the same operation much more rapidly and quite probably at a lower net expenditure of effort and money.

Bearing in mind the importance of increased rice production, we think that the application of the rotary principle probably represents a major advance worthy of attention wherever rice is grown; it is small wonder that the rotary cultivator has been hailed by many experts as the ideal implement for the preparation of rice land.

Fertiliser economics

THE United Kingdom maintained large subsidies on fertilisers longer than most other countries in Western Europe. As a result, very steep price rises have followed the two-stage operation of de-subsidisation in 1950 and 1951. More recently, as from February 1, 1952, further increases in price, due to rises in manufacturing and distribution costs since July 1951, have occurred. Nor for the future is there any real hope that prices can be kept at the current level. A far too significant drop in demand has followed all these price jumps and this in itself has adverse effects upon the ultimate price per ton that producers must charge if the supply of fertilisers is not to be an uneconomic venture. For with fertilisers, as with most commodities, costs per article or per ton will be lower if a plant is working to its full and steady annual capacity than if it is working below that level.

The seriousness of this situation cannot be glossed over. Britain's use of fertilisers per acre stands fairly high in any world list but it is still far below the minimum level that scientific opinion would consider adequate. Steady expansion, year by year, took place during the decade of subsidised fertilisers; contraction has swiftly followed de-subsidisation. Official (or political) recognition of this blow to progress was shown when a subsidy on phosphatic fertilisers was introduced in November 1951. It remains to be seen how much this praiseworthy action restimulates farming demand. Fertiliser usage stopped expanding in July 1950, and no single act of restimulation can have immediate effects for the point of view that ' fertilisers are too dear ' has made psychological inroads into the agricultural outlook.

Subsidies and credits

THERE are times when we wonder whether subsidy help is as vital as credit help. In less than two years fertiliser prices per ton have risen by 25%, 60%, and nearly 100% (according to type of fertiliser) and this means that any farmer who maintains his 1949-50 consumption must totally find, say, 50% more cash or credit. In Britain the greatest need for expansion or maintenance of fertiliser use is on the smaller farms; at least 75 per cent. of British farms are smaller than 150 acres. At times when all costs are rising, can

credit be so readily expanded—or hard cash so easily found? The return on fertiliser applications is not obtained until the crop has been lifted, sent away, and paid for; for crops used on the farm the eventual return may not come for much more than a year. Mr. A, a small farmer, should technically use twice as much fertiliser. But, to do so, he needs to find at least three times as much cash or credit as he did in meeting his fertiliser bills of 1949-50. This harsh reality may well be affecting fertiliser demand far more than any other aspect of the price increases. Is there not a powerful case for some special credit scheme to make it easier for smaller farmers to make adequate use of fertilisers? State credits to encourage the addition of plant-foods to British soils cannot cause inflation.

New Dutch International Study Centre

IT has been announced that Wageningen, the headquarters of Dutch agricultural education and research, is shortly to open its doors to both Dutch and foreign students of tropical and sub-tropical agriculture.

In many tropical and sub-tropical countries rapid development is taking place and modern machinery and new scientific techniques are quickly replacing older methods. In the circumstances there is an increasing need for agriculturalists with specialised knowledge and training in the various branches of agriculture practised in tropical regions.

To meet this an International Agricultural Study Centre has been set up in Wageningen, where higher education can be obtained in a number of subjects, in particular arable farming, market gardening and forestry as applied to the tropical and sub-tropical zones.

The new centre will work in close co-operation with the United Nations Food and Agriculture Organisation. Dutch and foreign students who already have a preliminary knowledge of agricultural subjects will be accepted for further courses and scholarships and bursaries will be offered to specialists for the completion of their studies. Students who have received bursaries under the technical assistance programme of FAO will also be able to avail themselves of the courses offered at the new centre.

The facilities so provided will be an addition to and an extension of existing provision in a similar sense at the Imperial College of Tropical Agriculture in Trinidad and at the Inter-American Training and Research Centre at Turrialba in Costa Rica. As such they should be welcome as they should help to meet the shortage of trained workers for underdeveloped regions in the tropical world which is at present proving so serious a handicap to progress.

Soil erosion in Africa

ONE result of the African Soils Conference which met at Goma in the Belgian Congo was the setting up in Paris of an Inter-African Bureau for Soil Conservation. This organisation has recently started the publication of an excellent review journal under the title of *African Soils*, the object of which is to publicise recent work on the subject and to review progress.

In the first number there are a series of articles by various authorities, which discuss soil conservation in different parts of Africa. Among these is one by Dr. H. Greene, Adviser on Tropical Soils at Rothamsted Experiment Station, who stresses that the most effective defence against soil impoverishment and erosion is the introduction of more satisfactory systems of land use, aided by modern technique such as plant breeding, pest control and the use of fertilisers and machinery. With the first part of this one can unhesitatingly agree. Efficient land use must be held to include all processes which help to maintain fertility and increase crop yields; within it are included methods of cultivating the soil which help to maintain its structure and lessen the impact of the forces tending to destroy this. They, like the other items mentioned, require to be integrated into an agricultural system, which will secure the desired end, *i.e.* higher yields and maintained fertility.

Erosion control

TO argue, however, that pest control or breeding higher yielding plant varieties can contribute anything *per se* to the lessening of soil erosion seems to us to be an over-emphasis. They are indeed necessary components of an effective agricultural system, but they affect it at different points. It is perhaps but right, in view of the vast amount that has been written about soil conservation, that there should be some redressment of emphasis, but the fact remains that properly devised systems of tillage and protective drainage should and must be an integral part of efficient agricultural systems. After all, soil protection measures are as old as any other part of agriculture, and in erosion-prone regions they have been practised since the earliest times. To underrate their importance as an integral part of agricultural systems would be unfortunate.

In many parts of the world erosion has, so to say, leapt into prominence during the past 20 or so years, and especially in the popular press there has been a tendency to publicise it as a new and terrible threat which requires elaborate *ad hoc* measures to combat it. Actually it is, of course, a symptom of wrong land use born of rapidly extending cultivation and rapidly accelerating population growth. It is, of course, quite wrong to assume that the introduction of specific measures to conserve the soil

can act as a panacea to all the evils which have followed, just as it is equally wrong to assume that the application of plant breeding or pest control alone can help to check erosion. The need is in fact for systems of land use which will cover all aspects, both physical and economical, and of these measures to ensure the protection of the soil play an essential and integral part.

Tobacco in Britain

A RECENT paper read before the Royal Society of Arts by Mr. Ronald Duncan throws remarkable light on the progress which amateur tobacco growing has made in England as a result of the efforts of successive governments to extract further contributions to revenue from reluctant taxpayers by the means of ever-increasing taxation on tobacco. We learn from this that 100,000 Britons are now growing their own tobacco, that the production of home-grown tobacco in 1951 was in the region of 200,000 lb., and that the loss to revenue involved will probably be £400,000, for tobacco produced by private growers for their own consumption is still mercifully exempt from duty. Such a loss judged by modern standards is, of course, trivial, but in the late Mr. Gladstone's day, for example, it would have caused that eminent statesman some sleepless nights.

One thing that appears to have been demonstrated is the suitability of the English summer climate for the production of tobacco. At an exhibition last year we were privileged to inspect some examples of the amateur growers' efforts and it is no exaggeration to say that in appearance, at any rate, they compared quite favourably with the average bright tobacco imported from other countries.

History of English tobacco

IT is curious how tobacco growing in England has been successfully discouraged by various governments, and the legend has grown up that climatically the country is unsuitable for its successful growth. James I could not apparently acquire a taste for it and issued a decree forbidding its use in any form, smoking being regarded, it would seem, as thoroughly immoral. Nevertheless, smoking rapidly extended as did tobacco growing in the 16th and 17th centuries, and by the beginning of the 17th century tobacco was one of the largest exports from England to Holland and Belgium.

By the end of the same century, however, tobacco growing had been virtually extinguished in England, thanks to the efforts of governments, who saw in imported tobacco a facile opportunity for collecting revenue, and merchants, who profited by the import trade. The present widespread amateur efforts are the first successful attempt to revive domestic production.

Under present conditions it is interesting to speculate whether the need for conserving dollar resources will lead to a resumption of tobacco growing in England on a larger scale, or whether the need for husbanding our dwindling arable acreage for food production and the exigencies of revenue collection for a programme of expenditure which is beyond the capacity of the country to support will lead once more to restrictions on tobacco cultivation which will check the efforts of the ever-increasing band of amateur tobacco growers to produce their own smokes and save their own pockets.

Salute to the hydrangea

IN this grimly economic world we seem to have less and less to say about flowers though in most societies flowers are still used to say the most pleasant—and sometimes also the saddest—things for us. A recent research report from the United States urges us to pay a passing tribute to the hydrangea, that most lovely of all flowering shrubs. For it seems that the hydrangea has been offering mankind more than beauty in white, pink, or blue; yet now that its medicinal secret has been prised open, the actual contribution of the hydrangea is likely to be only too quickly forgotten.

During War II when substitutes for quinine were so urgently needed, it was remembered that the Chinese for many centuries had used extracts from the roots of the Ch'ang Shan plant as a remedy for malaria. Unfortunately supplies of this Chinese plant could not be obtained at the time; so the help of botanists was enlisted. Their verdict was that the closest Western relative in the plant kingdom to the Ch'ang Shan plant was the hydrangea. Research workers prepared extracts from hydrangeas and it was found that these substances did in fact possess a useful anti-malarial activity. This activity was eventually traced to an alkaloid in the hydrangea plant.

It would be pleasant to think that here and there in the West small acreages would now be devoted to hydrangeas, providing a by-product of beauty while they build up supplies of an anti-malarial drug. Alas, the secret of the hydrangea has been discovered too late! Once the natural alkaloid had been isolated and chemically identified, research workers at the Lederle Laboratories not only found out how to synthesise it but also how to modify its structure so that its toxic side-effects were reduced without impairing its powerful anti-malarial properties. The new drug, though it owes its existence to the Ch'ang Shan plant and the related hydrangea, will not be bred in the greenhouse or garden tub but in the laboratory. At present undergoing final clinical trials, the drug is not yet named. We suggest that the name to be chosen might well pay tribute to the hydrangea.

There is a sober moral to this story, sober at any rate for growers. The knowledge that a specific plant contains some valuable substance is no longer a signal for expanded cropping. Once the substance is isolated chemists quickly find out how to make it in test-tubes. The modern chemist is both the creator and undertaker of specialised chemurgy.

Agricultural statistics

THE need for accurate and reliable statistics for agricultural production is obvious. In a world in which increasing anxiety is being felt concerning future supplies of food and agricultural raw materials, reliable statistics regarding production are the only basis upon which plans for development can be established and progress assessed.

Unfortunately current agricultural statistics, particularly in underdeveloped countries, are far from being satisfactory. Not only does the scope of the information collected vary greatly from country to country, but the standards and methods of collection also differ.

Consequently it is difficult to formulate a reliable picture for particular regions or for the world as a whole in respect of any particular item, while international comparisons are often barely feasible.

The matter has been highlighted by FAO in a recent circular, based upon experience gained during the world agricultural census conducted during 1950. They point out that in the more developed countries the individual farm is the unit of enumeration and the coverage is nearly complete. In most underdeveloped countries, however, there is hardly any attempt at systematic enumeration and the statistics reported are largely a matter of guesswork.

Sampling technique

THE need for improvement is clear and here FAO directs attention to the advantages offered by modern sampling techniques which depend on selecting a fraction of the whole area to be covered in such a way as to represent the whole. The method is of comparatively recent development and frequently administrators are hesitant to accept it as reliable. It is true that the details of its application may have to be varied to suit different conditions, but experience shows that it can provide a satisfactory basis for operation; moreover, it renders possible the assessment of the sampling error.

Efforts are being made to introduce the method to the notice of various governments, and to this end FAO is preparing a series of manuals indicating methods of collecting statistics, the application of the sampling method and the theory underlying it.

It is to be hoped that this initiative will in due course be productive of a much needed improvement in this highly important matter.

Fertiliser placement

THE recent discussion at Bedford, organised by the British Ministry of Agriculture and reported on another page, directs attention to the considerable economies in the use of fertilisers that can be made by fertiliser placement. The same point was stressed in Sir William Ogg's recent address to the Royal Society of Arts on February 20, an account of which we hope to include in our next issue.

It has now been established that for a number of crops, including potatoes, peas, beans and many horticultural crops, economies of as much as 30% of the amount of fertiliser required to produce a given increment of crop can be made by placing it in the row at a point where the plants can best take advantage of it, instead of broadcasting it. This is a discovery of considerable importance, especially at a juncture when the need for raising maximum crops is of such overwhelming importance while fertiliser costs have attained such high levels.

Already the latter factor has caused a considerable diminution in fertiliser use in the United Kingdom with consequent lowering of returns, and it is in the effort to correct this that the present Government have reversed the decision of their predecessors and reintroduced a measure of subsidisation for fertiliser applications.

It is not only in this country that placement has attracted attention; in the U.S.A., too, it is becoming widely popularised, while the recent work in Nigeria, in which the placement of granulated phosphatic fertiliser has been shown to produce marked increases of yield in groundnut cultivation, is being followed up on a large scale among peasant cultivators.

Obviously fertiliser placement has come to stay and in the future there seems to be every prospect that further work will reveal other directions in which economies can be effected in fertiliser use through the principles which the method embodies.

THIS MONTH'S COVER

A striking picture of rice terraces in the Bandoeng area of Java.

(Photo: Indonesian Embassy)

Bundles of rice seedlings ready for transplanting by hand in Northern Celebes

Fertilisers and Manures in Rice Cultivation

To provide a basis for discussions at the first meeting of the Working Party on Fertilisers of the International Rice Commission, held at Bogor in April 1951 under the auspices of FAO, a report was prepared by Dr. Vladimir Ignatieff based upon information obtained from a large number of rice growing countries. The data obtained also included information on water supplies for rice growing and on the soils of various regions. As the document in question contains much that is of interest the following critical review and summary of the main points has been prepared. The Working Party's next meeting will be at Bandoeng in May.

THE report is not a complete world summary of the position, since for various reasons a number of countries have been omitted, notably China and Korea; also the European rice-producing countries, in some of which considerable knowledge of production and manuring has been gained; while the African countries described include only those of least importance and Egypt, French West Africa and Madagascar are omitted. Moreover, there is no evidence to show that the effect of climate has been allowed for, although this is probably a factor of greater importance even than soils in influencing yields.

Bearing in mind the above-mentioned limitations, however, the report nevertheless contains much interesting information. In many cases the reporting countries have supplied information on water supply and paddy soils, and on the use of manures by farmers, as well as giving a detailed account of the manurial experimental work. It is convenient to consider these points and other matters in the working paper in a different sequence to that adopted by the author.

Water supply

The reports show that in all the important centres of rice production the crop is largely dependent on seasonal rains. Important irrigation systems have been established, but the area covered by them is but a small fraction of the total area under the crop.

Burma. The Burma crop is largely rain-fed, only about 10% being irrigated. Wherever rainfall exceeds 1,750 mm. paddy is regarded as a reliable crop. Where the rainfall is less than 1,250 mm., the crop can be grown without irrigation only in situations favourable for natural catchment. Heavy rains during the early part of the season affect the crop favourably, except where they cause flooding and impede cultivation. Heavy rain at the time of flowering has an adverse effect on the crop, as does absolute drought during this period, especially just before flowering. 'Ripening showers' as the grain is beginning to harden are considered essential for a heavy crop, and the fields must be kept wet until the crop approaches ripeness.

Ceylon. The range of annual rainfall in Ceylon is from 625 to 7,500 mm.; while total annual rainfall shows little variation, distribution is erratic, especially in areas of low rainfall. To make better use of rain, river, and underground water, especially in areas of light rainfall, water is impounded in storage tanks during the wet season and released for irrigation in the dry season. Probably half of the paddy land under irrigation is, however, still dependent on timely and adequate rainfall to fill the tanks and provide enough flow into the streams.

India. In India, nearly 80% of the cultivated area depends upon rainfall as the only source of water for growing crops.

The annual rainfall varies in different parts of India, but in the main paddy areas it appears to be in the region of 2,500 mm. The main rainfall occurs during the south-west monsoon which sets in early in June, and begins to withdraw early in September. The maximum rainfall occurs in July, approaching more than 1,000 mm. for the month in Konkan, while Malabar has 630 mm. in this month.

Pakistan. The area of greatest rainfall in Pakistan is the northern part of West Punjab and the north-west part of North-west Frontier Province; the driest sections are in Sind and Baluchistan. In the wettest of these the annual rainfall is about 1,500 mm. In the dry climate of West Pakistan irrigation systems have been developed on a large scale. Abundant rainfall is characteristic of all parts of Eastern Pakistan. The annual rainfall ranges from 1,400 to 3,500 mm. in different areas. Over a large part two crops are raised on the same land, and in some parts as many as three or four.

Philippines. In winter the north-east monsoon brings abundant rains from the Pacific to the eastern part of the Philippines, but the rains are not continuous and the dates on which they begin and end are very uncertain. From May to October cyclonic rainfall is brought by winds from the west and south-west. These rains depend for their frequency on that of the typhoons. The climate in the Philippines varies considerably in different places; in some areas there is one wet and one dry season in the year; elsewhere there are two wet and two dry seasons, while other areas show intermediate conditions between these two types. Rainfall therefore varies in time of incidence and in quantity in different parts of the country.

Thailand. The average annual rainfall of the Central Plain of Thailand is around 1,200 to 2,000 mm., the main rainy season being during the south-west monsoon. However, the rains are not very reliable, fluctuating from year to year and from place to place. In Southern Thailand the rainfall is about 2,000 to 4,000 mm. per annum, well distributed due to the effect of two monsoons (the south-west and the north-east) resulting in two rainy seasons in the year.

Soil types

Ceylon. In Ceylon, paddy is grown on nearly all soil types, provided water is available. The only soils on which it cannot be grown are the light, sandy types. The alluvial soils are generally confined to the more low-lying areas. They vary in depth and texture, and range from sands to heavy loams. The latter are fairly well supplied with organic and mineral plant nutrients, particularly the latter, but are often imperfectly drained. Deep drainage makes them highly fertile. These soils are chiefly used for paddy.

Physically, Ceylon paddy soils are lighter-textured and of poorer water-holding capacity than those of other countries. Underlying the surface soil, a subsoil has been developed of much heavier texture than the surface layer by years of puddling up to the depth of cultivation, with the object of retaining the soil water as long as possible.

The Ceylon paddy soils are generally poor in potash and lime, and to a lesser extent, in phosphoric acid, but contain fair quantities of nitrogen. They range in reaction from acid to slightly alkaline.

Low-lying peat soils associated with paddy do not occupy extensive areas in Ceylon. The peat is overlaid by an earth crust 30 to 90 mm. deep.

India. A general account is given in the report on the soils of India, but without indication as to which are associated with paddy cultivation. Presumably the paddy areas are on the black soils and the alluvial soils. The main features of the former are the depth, which may vary from 30 cm. to 6 m.; its loamy or clayey texture; the heavy cracks which develop in the summer season, extending up to 3 or 4 ft. deep; and the presence of a lime concretion zone at some depth and free carbonates mixed in the soil. The soils are usually deficient in nitrogen, phosphorus, and organic matter, but potassium and lime are generally sufficient. They may be irrigated, if done judiciously, without any deterioration.

The Indian so-called alluvial soils are an ill-defined group. They may come under various groups: desert soils, saline and alkaline soils, and meadow soils. These soils are the most important and fertile in India. They are deficient in phosphoric acid, nitrogen and humus, but not generally in potassium and lime. They produce a wide variety of crops, including paddy.

Java. Soils deficient in phosphate are common in the rice-growing areas of Java; in fact, they occur to a large extent in the extensive lowland plains, where nearly all arable land is occupied by paddy. These phosphate deficient soils include the white dacite bleached tuff laterite of Northern Bantam and West Batavia, covering an area of about 70,000 hectares; the yellow and greyish-yellow laterite loamy soils in Krawang and Indramaju, covering about 100,000 hectares; the various marly soils found over wide areas in West and East Java and on the island of Madura; and the sandy quartz soils in East Java and Madura.

Pakistan. An account of the soils of Pakistan is not connected with the paddy areas. However, the alluvial soils predominate in most areas, many of which are deficient in lime, humus, nitrogen and phosphorus. The new alluvial soils, however, contain adequate quantities of lime, potash and phosphorus. In some areas there appears to be a saline problem, but in areas of heavy rainfall these salts are easily removed.

Philippines. An account is given of the soils in the Philippines, but without reference to the paddy areas. It is noted, however, that in some parts there are small but significant areas of black soils (Rendzinas) developed on limestone. They are heavy in texture and sticky when wet,

Peasants transplanting rice in the Northern Delta area of Egypt

slightly acidic, but may be neutral or even slightly alkaline. There are important areas of alluvial soils, having the widest distribution and the greatest agricultural importance in the great central plain of Luzon.

Thailand. The Bangkok plain of Thailand consists mainly of heavy dark clays developed from fine-grained alluvia. The annual floods deposit some silt over much of the plain; where little or no silt is deposited the soils are more acid, darker coloured, with a red subsoil, and have much lower productive capacity. Along the western, north-western, northern, and north-eastern parts of the plain are limited bodies of slightly higher, less well-developed silt loams to light clay loams. These are potentially the best soils in the region. The most important paddy-growing area in the Southern Region consists of a large plain of heavy, dark clay. West of this plain are grassy plains of very acid, phosphorus-deficient loams and light clay loams potentially important for paddy.

Ricefields in Java, with Tangkoeban Prahoe volcano in the background

Peasant women planting out rice seedlings in wet paddy

Results of fertiliser experiments

Although there are significant differences in the requirement of the paddy crop grown on different soils, yet a number of generalisations can be made in regard to nitrogen, phosphorus, and potassium. There is a widespread need for nitrogen. Of the inorganic forms of fertilisers tried, ammonium sulphate appears to be the most effective, though in some cases ammonium nitrate has given equally good results. Compared on an equal nitrogen basis, oilcakes appear to be as effective as ammonium sulphate. In some countries it has been found that applications of ammonium sulphate and ammonium phosphate, while giving good increases in yield in the initial years of application, cause a decrease in yields in succeeding years. The continual use of certain fertilisers also results in a residual acidity in the soil, soils that are already acid, or sandy soils that are readily made acid being the first to show decreased yields on account of excessive acidity.

When nitrogen requirements have been met, good responses to phosphorus have been obtained in many countries, although there are notable exceptions to this. Few significant responses to potassium fertilisers have been reported.

Good results have been obtained with bulky manures such as farmyard manure, cattle dung, compost and green-manure crops, whether grown on the paddy fields where conditions are suitable, or brought from other sources.

Organic matter is of the greatest importance in maintaining soil fertility. Because of high temperatures and seasonal high moisture content of the tropical soils, organic matter undergoes very rapid decomposition, so that many of the soils are poor in humus.

Boron, iron, calcium, sulphur and magnesium are required by the paddy plant in fairly large quantities.

Application of fertilisers

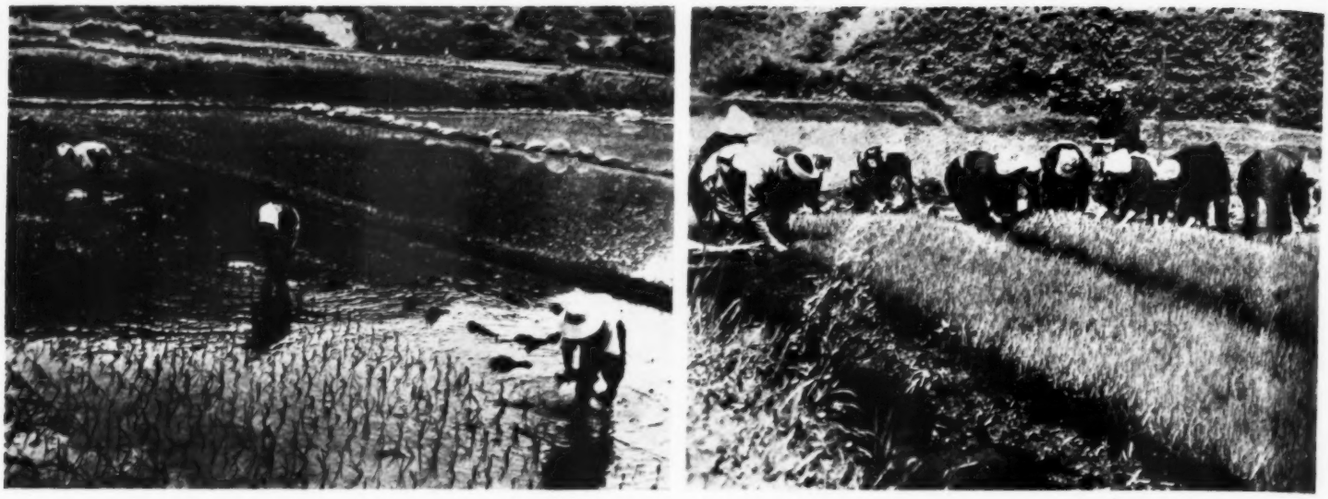
It is not yet possible to generalise about the best time and method of applying fertilisers and manures. Bulky manures are usually ploughed in when the land is being prepared for the crop. From Ceylon and Indonesia comes evidence that after these manures have been dug in the land should be retained in a well-moistened condition to prevent the ammonia released in decomposition from being oxidised to nitrates.

The evidence as to time of application of nitrogen fertilisers and of organic materials rich in nitrogen, such as oilcakes, is conflicting. Similarly, the application of nitrogenous fertilisers in several doses have been tried with variable results in different countries. Little information was gathered regarding the time of application of phosphate fertilisers alone.

Rotations

The Report succinctly summarises the position regarding rotations in the following words:

'Whether two or more crops of lowland rice are grown consecutively on the same land, or whether rice is rotated with other crops, depends on a number of factors, chief of which are the



(*Left*) **Planting out seedlings and** (*right*) **weeding paddy somewhere in South-East Asia**

distribution of rainfall, the availability of irrigation, the topography, and the soil texture. In many of the rice-growing countries the rains have ended by the time the main rice crop has been reaped and there may not be enough moisture to grow another crop. In many areas under irrigation, or with a greater and more even distribution of rainfall, or where the soil is new river silt, retentive of moisture and easy to work, and where atmospheric humidity causes heavy dew or morning mist, it is possible to raise two consecutive crops of paddy within a year, or green manure preceding paddy, or some other crop following paddy. Three crops of paddy in one year or some other combination of crops are possible in some very favoured areas. The topography of some areas may be such that the land is too wet the year round for any crop but paddy. It is, however, a remarkable and not yet completely explained feature of rice monoculture in South-east Asia that land can apparently be cropped continuously with rice, albeit generally at low levels, without noticeable deterioration in yields.'

Use of manures by farmers

The use of fertilisers on paddy land is not general throughout the United States, although it has increased in the southern areas in recent years. In California, the application of 35 to 70 kilograms of nitrogen per hectare at seeding time is recommended and extensively used.

Some cultivators in Burma use artificials, many others use cow dung and bone meal, more usually in the nursery than in the field.

In Ceylon the Government have distributed a considerable quantity of fertiliser to paddy growers in recent years, but it appears that cultivators still rely mainly on green manuring, the bulky manures, and the penning of livestock. 'Bone chips' remain the most popular fertiliser.

Cultivators in Hong Kong use nightsoil, groundnut cake, ash, fishmeal, bonemeal, dried animal manure, but ammonium sulphate is the only chemical fertiliser used (by those who can afford it).

Bulky organic manures of various origins are in general use in India, only a restricted use being made of artificials. Mysore State is 'manure minded,' the cultivators making considerable use of both natural and artificials for paddy. Because of shortage of fertilisers, cultivators apply 17 kg. of ammonium sulphate and 11 kg. of phosphoric acid per hectare; the latter is applied one month after transplanting, the former just before levelling the land.

Artificials as well as organic manures are largely used in Japan, and in heavy applications. Before the war, ammonium sulphate was applied at the rate of 190 to 380 kg. per hectare. In 1949 the Government distributed sufficient nitrogen to apply 44 kg. of nitrogen per hectare for the rice crop. Superphosphate or basic slag has been used; before the war the former was applied at the rate of about 200 kg. per hectare. Lime has also been widely used, usually just before the spring cultivation, at the rate of 370 to 555 kg. per hectare.

Cultivators in Pakistan realise the value of green manures, but there are limitations to their use. They make a limited use of farmyard manure, tank silt, compost, bone meal, and ammonium sulphate on autumn paddy and winter transplanted paddy.

Commercial fertilisers have been used in the Philippines only to a limited extent for improving paddy yields.

The rice crop in Thailand is not usually manured, but in certain instances it benefits to some extent from applications made to other crops in the rotation.

Rock phosphate of local origin has been used for a long time in paddy cultivation in the Tonkin region of Viet-Nam. There is no evidence that other fertilisers are largely employed in that country.

Determining fertiliser needs

Field experiments, including trials with animal manures, commercial fertilisers, and soil amendments on the principal soil types, should be the basis of the soil fertility programme.

The value of statistical method is beginning to be more widely appreciated, for the results of many early experiments have proved of little value because of faulty design. The experiments should be designed so as to apply different plant nutrients singly and in combination at different rates, so arranged that some dressings are definitely below and others definitely above the optimum amount.

The scientific classification and mapping of soil areas should precede experimentation, and the knowledge so gained used in selecting sites for experiments representative of the soil types.

It is unfortunate that soil classification and mapping has not received the support it deserves in most of the rice countries.

Problems awaiting solution

The problems which still need solving by field experimentation in many of the rice-growing countries are:

1. Increases in yield by the use of the different plant nutrients.
2. Residual and cumulative effects of fertilisers and manures.
3. Optimum combinations of manures and fertilisers.
4. The best time and method of applying manures and fertilisers.
5. Responses of different varieties of rice to fertiliser treatment.
6. Rotation crops most responsive to fertilisers and manures.
7. New rotations.

D. H. GRIST.

The Reclamation of Mangrove Swamp Areas for Rice Cultivation

WITH REFERENCE TO THE SCARCIES DELTA IN SIERRA LEONE

HECTOR MACLUSKIE, Dip. Agr.
Formerly Senior Agricultural Officer, Sierra Leone

Masawari polder where rice was first produced from 1938 to 1942 and where good crops are still grown

A rice area at low tide. At high tide the area is completely inundated

(*Left*) **Avicennia mangrove showing the carpet of pneumatophores beneath the branches**

Increase of rice supplies is a major world problem. In many parts of the tropics there are large areas of mangrove swamp which could be reclaimed for rice growing, notably in West Africa. This article describes the problem of reclamation as it presents itself in Sierra Leone where not inconsiderable developments have already occurred.

THE Scarcies delta in Sierra Leone lies at the mouths of two large rivers, the Great and the Little Scarcies, in latitude approximately nine degrees north, and is about 90 to 100 square miles in extent. These rivers, of which the Little Scarcies is oddly enough the larger, rise in the north of Sierra Leone and flow towards the Atlantic carrying in suspension silt, which is deposited on the flood plains where the flood waters meet the incoming tides.

In the tidal reaches the flood plains are narrow at first, but towards the sea merge into wide stretches clothed with mangrove and intersected by numerous tortuous creeks and tributaries; they are subject to flooding at spring tides only in the dry season and to regular diurnal irrigations when the rivers, swollen by the rains, are banked up by incoming tides.

In the dry season, which extends from November to the end of May, the waters which thus irrigate the plains are saline for three to six months according to the proximity to the sea, but they are fresh when the rivers are in flood. As a result it is possible to grow rice only once a year, during the wet season. The period of freshness increases as one proceeds downstream until near the sea it is too short to allow a rice crop to be grown, and it is there also that the largest unexploited areas of mangrove forest exist.

The reclamation of mangrove forest land for rice production has made remarkable progress in Sierra Leone and, in the Scarcies delta where felling began over 60 years ago, rice has been grown without interruption ever since. This reclamation has dealt with nearly half the potential area and is a remarkable achievement since it was done by the native African inhabitants of their own initiative and without Government assistance. Time has shown, however, that certain mistakes were made which should be avoided if really satisfactory land utilisation is to be achieved. The reclamation, though arduous, was straightforward and entailed only the felling and clearing of the mangrove. The plain thus exposed was dug and planted with rice which in due season was harvested. No other work was done and no water control was practised. The crop was, naturally, irrigated twice daily by the rivers, while the annual rainfall averages 110 in.

The area directly available for planting with rice was determined, therefore, by the freshness of the flood water, while further expansion and exploitation of the mangrove forest depends upon the exclusion, and/or expulsion of salinity from the reclaimed areas.

Characteristics of the mangrove forest

In the main the mangrove forest consists of two kinds, *Rhizophera recemosa* or fresh water mangrove, and *Avicennia nitida* which thrives in saline places.

Rhizophera recemosa, the familiar deep, arched rooted variety which grows to immense heights under favourable conditions, clothes the banks of the rivers and creeks throughout the tidal reaches. Near the sea it forms a fringe, behind which are found pockets of the Avicennia mangrove, varying in size up to 1,000 acres and which has an entirely different habit of growth. This tree grows on one stem only, while the roots are shallow and spread laterally just beneath the surface, throwing up pneumatophores which carpet the surface of the ground. The leaves in the dry season and in dry weather are coated with crystals of salt which are formed in the process of transpiration. The surface soil

upon which it grows is used by the natives for extracting domestic salt or 'Samu' salt of the trade. It is clear, therefore, that Avicennia mangrove tolerates saline conditions. Rhizophera displays no such tolerance and though it grows where saline waters flow, its deep arched roots penetrate to a soil layer different in character from the surface clay which supports Avicennia.

The difference in habit between the two types influences to a great degree the methods necessary for the exploitation of mangrove swamp lands for rice growing. Moreover, the soils which support the two species differ considerably, Rhizophera growing on deep, dark coloured river-borne mud, while Avicennia soils are firm, grey, somewhat impervious clays of marine origin.

When mangrove felling was first begun and for many years after the characteristics of the two kinds of mangrove were apparently not fully appreciated; both kinds were felled for rice growing and today there are in the lower reaches of the plains large areas of abandoned land. Enquiry showed that the abandoned areas originally supported Avicennia mangrove and it was the presence of the salt which they required which brought about the abandonment of rice growing. It is now known that Avicennia mangrove areas must first be empoldered and salt removed before rice can be grown successfully.

Silt balance on unprotected lands

The question whether the rate of deposition of silt by tidal waters on unprotected cleared rice areas is greater than the rate of its removal by wash has been much discussed in recent years. The flood waters which irrigate the rice lands are heavily laden with silt and it has been assumed that this accumulates and helps to maintain fertility. On the other hand, at periods of low tide there is a swift run off the land, and as it is also exposed to heavy rains it is equally safe to assume that a considerable quantity of silt is removed since there are no control measures to prevent it.

The writer is of the opinion that in these conditions the rate of silt exceeds its deposition loss rate, particularly in the lower delta, and that erosion is, in fact, in progress, with consequent gradual reduction in the fertility of the land. This view is supported by statements from older farmers who maintain that their farms do not yield as well as they once did, and by measures which certain farmers on their own initiative are adopting to prevent surface erosion.

One predisposing factor to erosion is

A corner of the Mambolo polders scheme, showing two drains and bund between

the total clearance of mangrove, particularly from the creek and river banks. Farmers are now awakening to the need for re-establishing protective vegetative growth in such places, and indeed local tribal authority rules are being considered which will enforce replanting of protective vegetation at appropriate points.

Tributary creeks to main rivers, which have been cleared mainly for use as highways for canoes and boats, have through the years widened very much and the farms on their banks have consequently been much reduced in size. One creek which, according to local estimate, was first opened for canoe passage 36 years ago, can now accommodate easily a 36-ft. launch, and there is little doubt that this process has extended greatly.

Native protective methods

The main river banks deprived of vegetation for their support are perpendicular and crumble, but where fringes of mangrove have survived the feller's axe, they are sloping and stationary. These signs of erosion are most severe in the lower reaches where the full force of the ebb flow is felt; in the Little Scarcies' tributaries surface erosion is very serious indeed, and it is here that efforts by individual farmers to halt this deterioration are most commonly met with. The methods used are described below.

Surface staking. In Kayinti creek in 1949 certain farms, after weeding, were covered at close intervals with pegs which fixed the weeds to the surface. The object was to offer some protection to the newly dug surface and prevent its wash by swift tides.

Late weeding. In recent years the weeding of Kiri kiri (*Paspalum vaginatum*) was delayed until just before planting time, with the result that the weed was merely checked and not killed out. By doing this, it is claimed, the surface soil is afforded some protection.

Creek blocking. The mouths of many little tributaries and creeks which wind their tortuous way through rice fields have been blocked by bunds to impede and slow down the ebb flow and thus help to check surface wash.

Bunding. Several farmers have completely bunded their farms so as to slow down the surface flow, gaps being left in the bund to allow the flow and ebb of tidal waters. One farmer claimed that a year or two after bunding his yields improved.

Mangrove planting. Some farmers have surrounded their farms with hedges of Rhizophera mangrove to protect the creek boundaries.

In the lower Little Scarcies area the surface soil is eroded to such an extent that the land is no longer muddy and difficult to walk upon but is firm to the tread at low tides. It was also noted that the raised lip which invariably fringes rivers in the Scarcies delta has in some cases entirely disappeared and the reverse conditions of depressed banks have taken its place.

Soil erosion in cleared mangrove is therefore a fact to be faced and unless measures are adopted for its control deterioration will continue.

Effects of bunding

The most successful way of stopping surface erosion is by bunding. In other rice-growing countries water control, and therefore soil stability, is achieved only in that way.

Local experience of bunding, however, has shown that caution is required. Early tide-excluding polders made at Rokupr, Luti and Funkadeh were ruined temporarily by the appearance on the surface of the soil of highly concentrated acid salts of iron sulphate which are inimical to plant life. It was later established that when the toxic areas were opened to the tide, the land rapidly became cleansed of the toxic compounds and rice grew again, better it seemed than ever before.

Observations upon the toxic problem at that time led the writer to believe that it was confined to land which had previously supported Rhizophera mangrove.

The toxic problem as it was called, led to a series of observation plots being laid down at the Rokupr Rice Research Station. The results of these are fully reported in detail in annual reports and they may be briefly summarised as follows:

(*a*) Complete control by empoldering produced the toxic problem and made rice growing impossible.

(*b*) Exclusion of tides for six months during the dry season followed by tidal

irrigation in the rain season enabled rice to be grown fairly well.

(c) Exclusion of tides for the six rainy months and allowing irrigation with dry-season tides also produced a fair crop.

(d) Bunding with low bunds which permitted the free access of tides but controlled their speed of flow produced very encouraging crops of rice. The results are shown in tabular form below.

These experiments were carried out on land where saline tide conditions are of short duration (March to June), and while they demonstrate the advantages of low bunds and their effect on soil movement they do not provide the answer to the reclamation of Rhizophera mangrove where tidal waters are saline for the greater part of the year and therefore preclude the growing of rice by ordinary means.

It is hoped that in time this problem also will be solved so that the extensive unexploited areas of virgin Rhizophera mangrove near the sea may be reclaimed.

Meantime low bunds which protect the soil and do not impede tides are a very encouraging line to follow in the existing rice areas. The application of the principle might well increase yields and in a short period of years repay their cost.

Empoldering

The reclamation of Avicennia mangrove forest land is so different that it is dealt with separately.

It has been shown that Avicennia mangrove thrives in a saline environment. It is therefore necessary to expel the salt before rice can be grown. This can be done only by empoldering.

Early experiments with polders established by the writer at Maswari in the Colony Peninsula of Sierra Leone between 1938 and 1942 have since been extended. The land is still growing satisfactory rice crops. Since then much information in the reclamation of Avicennia land has come to light.

Dougall, in his report on a ' Visit to the Gambia and Portuguese Guinea ' in 1948, showed that in Portuguese Guinea rice growing is confined to Avicennia land and that Rhizophera land is avoided. This is clearly visible to the air traveller en route from Freetown to Bathurst.

Aerial view of mangrove swamp areas in Sierra Leone, showing cleared swamp areas

In the Scarcies most of the land which was available for straightforward clearing for rice is cultivated. The toxic problem has called a halt to the reclamation of Rhizophera areas near the sea, so the exploitation of Avicennia areas has great significance.

Recent aerial surveys of mangrove forest in the Scarcies area show that there are approximately 5,000 acres of Avicennia mangrove. This revealed a profitable line of development and the empoldering of these areas began in Manbolo chiefdom in 1949 and continued in 1950 and 1951. In 1949 ten acres were reclaimed at a cost of just over £5 per acre. In 1950 the Mambolo polders scheme was started with a loan from the Government to the native administration and 95 acres more were empoldered at a cost of less than £5 per acre. The initial work was done by the Rice Research Station staff; it is now being continued under the direction of the Land Drainage Branch of the Public Works Department. In 1951 another 100 acres were added to the Mambolo polders, while about 100 acres more were empoldered in Samu chiefdom where the native administration obtained a loan for the work. It is anticipated that these schemes will continue to develop on a greater scale.

Polders do not present any serious engineering difficulties. All that is required is to surround the area to be reclaimed with a bank or bund of sufficient height to exclude spring tides. The procedure is to make a perimeter drain to a prescribed size round the area and use the spoil to build the bund. Small or large sluices are placed in the bund, usually near the creek so that excess rainwater within the polder may be expelled at low tide, taking with it salt in solution. The soil is thus washed until it is fresh enough to grow rice on; this occurs generally in the second, and certainly in the third year, after the polder is made.

In the Scarcies where the rainfall is about 110 in. per annum, sluice dimensions at the rate of 4 sq. ft. per 10 acres of polder have been found to be ample. In theory one large sluice for a large area is deemed to be best, but this is not always the case in practice, for it may be found more convenient to divide the area to be empoldered into a series of smaller units with their own simple native timber sluices easy of maintenance, than to have one large concrete sluice costly to erect and requiring scarce imported materials.

Avicennia land is flat and undivided by creeks; it is therefore suitable for mechanisation and units of 20 to 40 acres which are large enough to provide a few days' work for a tractor unit, and not too large for adequate water control, may well be the most practical size.

WATER CONTROL EXPERIMENT—ROKUPR RICE RESEARCH STATION

Plot	*Treatment*	*Yield of Paddy in Lb. per Acre*				
		1946	1947	1948	1949	1950
A	Bunded, water control from June 15 to December 15.	860	510	1,500	1,110	1,770
B	Bunded, water control from December 15 to June 15.	1,560	690	1,785	885	1,395
C	Full water control with tides excluded all the year.	210	Nil	Nil	Nil	Nil
D	Unbunded—tidal conditions	1,100	690	1,290	1,170	1,350
	Low bunded plots which permit tidal irrigation but control its speed of flow					
X	Good marginal land	—	—	—	1,640	2,000
Y	Poor land	—	—	—	1,110	2,055

It may be added that in addition to the work carried out by Government staff, many small polders widely scattered have been made by the cultivators themselves during the past eight years. What is now required is to organise the work of reaclmation on an orderly basis with community settlement. This is envisaged in the Kambia District Economic Development Plan.

Conclusion

An attempt has been made to describe the methods of mangrove reclamation as at present practised in Sierra Leone. It is thought that experience there acquired may be of value in similar development in other parts of West African mangrove forests.

In such work it is well to keep to the forefront the dangers of soil deterioration and try to eliminate them. Soil conservation should be the rule, and whether this is done by polders, by low bunds or simply by protective fringes of vegetation is a matter for local decision.

RELEVANT PAPERS

'Survey of the Scarcies Rice Areas.' By Glanville. Sierra Leone Sessional Paper, 1930.

'Some Problems of Empoldered Rice Lands in Sierra Leone.' By J. M. Dent. *Empire Jour. of Exp. Agric.*, 15, No. 59, July 1947.

'Rice Growing by Empoldering: Developments in Sierra Leone.' By H. Macluskie. *Farm and Forest*, December 1943.

'A Note on the Reclamation of Soils Inundated by Sea Water.' By H. Dougall. *Transactions of the International Congress of Soil Science*, Vol. I. Amsterdam, 1950.

'Factors Concerned in the Reclamation, Poldering and Fertility of Certain Riverain Soils in Sierra Leone.' By H. Dougall. *Transactions of the International Congress of Soil Science*, Vol. II. Amsterdam, 1950.

Annual Reports of the Rokupr Rice Research Station and the Department of Agriculture, Sierra Leone.

New Use for Rice Hulls

A waste product of hitherto little commercial value—the rice hull—has been found to have an important use as a filler or diluent for seeds mixtures. Workers of the U.S. Soil Conservation Service in California, reports the *Rice Journal*, have discovered rice hulls to be the most economic and effective addition to seeds mixtures for sowing with a grain drill. Previously farmers were having difficulty in sowing mixtures of different kinds of grass seeds in a single operation and getting uniform distribution of all seeds, regardless of their size, shape or weight.

It seems that each hull acts as a cup which holds a small cluster of the different seeds in the mixture; these not trapped in the hulls 'float' in the small spaces between. It has been found from experience that the optimum rate of rice hull used with small grass seeds is about 16 lb., or two bushels of hulls per acre.

Experimental rice plots in Northern Italy

Rice Growing in Europe

Some Recent Developments

Rice is usually considered a tropical crop, but it has long been cultivated in Southern Europe, notably in Italy and Spain, where yields are among the highest in the world. Of late years rice shortages have attracted attention in several European countries to the possibility of extending rice cultivation.

RICE growing in Europe has for long been practised, but before the last war the only countries in which it gained any really substantial production were Italy, Spain and Portugal.

It is worth noting here that although rice is usually considered a tropical crop, when it is grown as a summer crop in warm temperate latitudes, yields per acre are much higher than when it is grown in the full tropics. The following figures illustrate this point.

AVERAGE YIELDS OF CLEANED RICE PER ACRE IN WARM TEMPERATE AND TROPICAL COUNTRIES

Tropical countries. *Cwt. clean rice per acre*		*Warm temperate countries.* *Cwt. clean rice per acre*	
Burma ..	6.5	Spain ..	26.0
Siam ..	6.0	Italy	22.3
Indo-China	5.6	Portugal ..	16.0
India-Pakistan	6.9	Japan ..	22.5
		Australia ..	22.0
		U.S.A. ..	12.6

The reason for this is not altogether clear. It may in part be attributable to better cultivation and the use of fertilisers, while the effect of the winter climate on the soil may also have some influence, but it has been suggested that possibly an important contributory reason may be photoperiodism and the longer summer day length, which combined with the high day temperature and irrigation produce optimum conditions for growth.

Italy

Italy has always been the largest producer and in the years before the war the average annual production of cleaned rice amounted to between 500,000 and 600,000 metric tons of which 137,000 tons were exported, the remainder being consumed in Italy itself, while the total area cultivated averaged roughly 400,000 acres.

The industry is largely confined to Northern Italy, the most important producing area being in the Lombardy plain around the town of Vercelli. The River Po and its tributaries which traverse this region supply abundant irrigation water for the crop by means of an elaborate system of irrigation channels.

The crop is well cultivated on an elaborate rotation system comprising rice, dry grains and temporary grazing leys mainly used for dairying, while fertilisers are extensively used.

The Rice Experimental Station at Vercelli established in 1908 has largely contributed to its development on modern lines.

During the latter stages of the last war the industry suffered severely since the Lombardy region was the scene of fierce fighting, and production declined to half the pre-war average in 1944-46. Since then it has revived, production in 1948 amounting to 400,000 tons.

Rice yields per acre are among the highest in the world and average approximately 22 cwt. of cleaned rice per acre.

Spain and Portugal

Rice cultivation in Spain is also of very long standing, although probably shorter than in Italy from which country it has borrowed much. In Spain cultivation is mainly confined to Valencia and Tarragona; the total area under the crop is approximately 120,000 acres and the average annual total production is of the order of 160,000 tons per annum, almost all of which is consumed locally, exports only amounting to a few thousand tons per annum. The crop is well cultivated, fertilisers are extensively used and yields are high, amounting to approximately 26 cwt. per acre, which is the highest in the world and exceeds those of Italy. In Portugal the crop averages 50,000 tons and is produced on 60,000 acres. Yields are again high but somewhat lower than in Italy and Spain, averaging 16 cwt. per acre.

Recent extensions of production

Since the war shortages of rice production in Eastern countries and consequent high prices have encouraged the development of rice growing in a number of other European countries, notably Greece, Southern France and Hungary. A brief account of the position in Greece was given in an article by Dr. C. de Fellner in

Harvesting rice by sickle, Southern France

WORLD CROPS, Vol. 3, p. 211, and it may be recalled that here considerable efforts are being made to extend the cultivation of rice with the assistance of the ECA Food and Agriculture Mission. Attention is being paid to the reclamation of extensive tracts of salty and abandoned lands in the river estuaries, notably at Anthele, by means of drainage and irrigation, for the cultivation of rice. Already the area under rice has increased from 5,000 acres pre-war to 25,000 acres, with an anticipated yield of 33,000 tons of paddy or 20,000 tons of cleaned rice.

Southern France

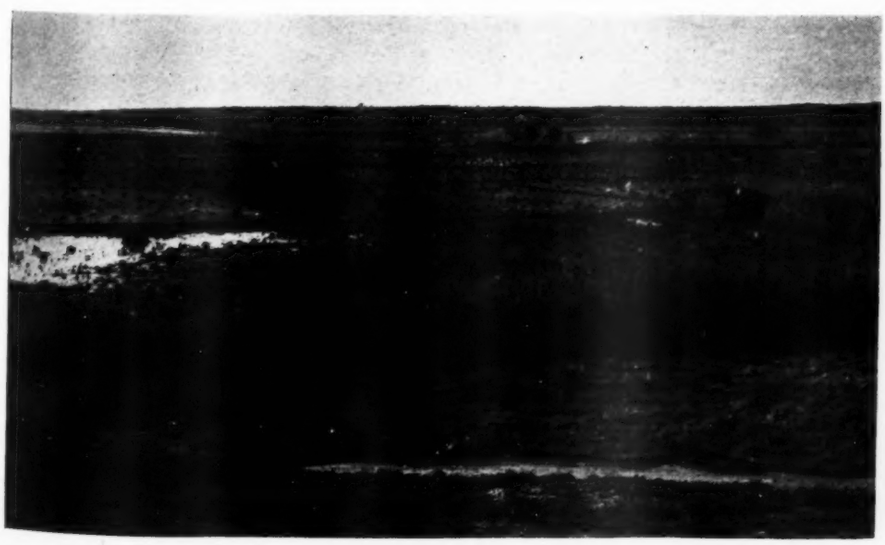
Most of the rice grown in France comes from the waste and salt-spoiled land in the Rhône delta known as the Camargue. This region in ancient times produced much of the cereals needed by the Roman Army and was regularly irrigated by the Rhône floods until the river was enclosed between dikes to make navigation safer. The effect of these was to deepen the river bed, thus lowering the water level and making floods less likely, and as irrigation by pumping was not easy in those days, the soil of the Camargue dried out, lost its fertility and became impregnated with salt. The land is, however, easily flooded by modern methods, even though it may be costly to excavate large irrigation ditches, and drainage is equally expensive.

The farms of this Camargue consist of large holdings, and it was not difficult for the farmers there to find the capital needed. From 1945 until 1950 the price of paddy was three to three and a half times the price of wheat, and rice therefore became a very paying crop; accordingly the acreage cultivated under rice increased from barely 2,000 in 1945 to about 45,000 in 1951.

Earth moving plant of American make is used for levelling the land and mechanical navvies for ditching. Unlike Spanish and Italian cultivation methods, in Provence all tillage is done before flooding.

The only operations carried out in the flooded field are sowing, broadcasting by hand or scattering by airplane and, occasionally, the transplanting of rice seedlings when the rice is sown in nurseries for later transplanting into the fields. Transplanted rice is usually hand weeded.

At harvest time the paddy fields are usually drained before reaping although modern 'combine harvesters' on caterpillars *can* work in water. Possibly the commonest way of reaping is by hand with the sickle, but the scythe is also much used and there are a few reapers and reaper-binders in use, although, light as they are,



Rice field in the marshes of Les Beaux, near Arles on the Rhône River, France

these wheel-mounted machines are easily bogged. Many farmers reap their entire crops with the sickle, although it takes a man six days to cut an acre (the combine cuts in similarly good conditions 10 acres in a day), because, they say, the paddy grains are less inclined to drop off when cut by hand than with machine or scythe.

Rotations in cultivation are not much practised on account of the high price of rice. Rice follows rice year upon year, but farmers maintain fertility by the use of fertilisers, particularly nitrogenous ones, dressings containing as much as 100 lb. of nitrogen per acre being given. Barley, maize, lucerne and grass have been suggested as possible rotation crops. Rice straw is often dug in as manure, but the semi-wild cattle of the Camargue eat the straw readily in winter and transform it into manure more quickly.

The average yield of paddy (unhulled rice) in 1950 was 32 cwt. per acre, but this value is heavily weighted since a large area of land was carrying its first crop which usually yields less than later ones. For similar reason, previous years' average yields were even lower and from 1945 to 1950 the average was 24 cwt. per acre.

Rice in Hungary

Rice is an important article of diet in Hungary and the present average annual consumption is 3 kg. per head of the population. In the past, much rice was imported, which meant that supplies were cut off during the war and the serious world shortage of rice has curtailed supplies in recent years.

The idea of growing rice in Hungary, with its long cold winter and hot dry summer, was first considered in 1938, when Hungarian scientists received seed of 103 varieties of rice from a scientific institute in the Soviet Turkmenian Republic. Experiments showed that a type named Dunghan Shali was most suitable for Hungarian conditions. It has a growth period of 125 to 140 days, which fits in with the Hungarian summer, and yields as much as 35 quintals per hectare, with careful cultivation.

This is slightly less than the yield in Japan, but greater than that of China. It is well above the yield in India and South-East Asia.

Until 1945, however, rice growing was little developed. In 1944 only 4,500 hectares were cultivated and most of this was overrun during the big battles of the last year of the war. In 1945 no more than 100 to 120 acres in small plots were cultivated.

Government policy strongly favoured and encouraged rice production, and the first task was the restoration of the rice fields and the provision for their further extension. By 1946, rice was growing again on 3,400 hectares, and by 1951 the crop was harvested from 17,000 hectares.

Rice fields in the Hortobogy Plain, Hungary

At present many small farmers are growing rice on their own holdings, using improved seed provided by research institutes, and there is a significant increase in the area under rice. They are able to sow fields of as much as 200 to 300 hectares in extent, and last summer experiments in mechanising the rice harvest were begun.

It was found that if the rice fields were drained before harvesting, an adapted combine-harvester could be used to reap the crop. The machine harvests about 4 hectares a day, while it takes 40 workers to harvest 1 hectare a day by hand.

The cultivation of fish in the flooded rice fields has proved a profitable sideline; research has shown that carp adapt themselves successfully to the conditions and do not harm the growing rice plants, while they also eat mosquito larva; when the fields are drained the carp are collected in ponds until they are ready for sale.

Experimental stations have in hand the task of finding land suitable for rice fields and the selection and development of high-yielding strains of rice possessing disease resistant and other desirable qualities.

At a time when the food situation is becoming increasingly serious in many countries, the successful Hungarian experiment shows how research can overcome climatic and other difficulties facing the need to grow more food. Present water control plans mean that the rice area will be extended as suitable irrigated fields become available. It is planned that by 1954, at the end of the present Five-Year Plan, a total of 102,500 acres will be under rice.

Acknowledgments

In the foregoing article the section on Southern France was supplied by J. S. Scott and that on Hungary by Neil Stewart.

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American Rice Improvement

Workers in America are reported in an essay sponsored by the American Society of Agronomy, recently reproduced in *Crops and Soils* (December 1951), to be seeking a commercial, salt-water tolerant variety of rice which when found will considerably increase the potential rice-growing area in Texas, Louisiana and Mississippi. A variety imported from India has shown promise of salt-water tolerance and breeders are trying to incorporate this characteristic into some standard varieties.

An improvement in American rice farming is the introduction of a rice-pasture rotation. Grass and clover are seeded in the rice stubble after harvest and given a dressing of about 3½ cwt. of fertiliser, both seeding and dressing being frequently carried out by aircraft at a rate of around 40 acres an hour.

The ensuing pasture can be stocked with three times the number of cattle that unimproved pasture can take. Rice yields following the improved pastures have shown increases of 2.86 barrels over rice yields following unimproved pastures.

Potentialities of Upland Rice

Upland rice is the term applied to rice which is grown as a dry crop, in contrast to swamp rice where the crop is kept submerged in water for the greater part of the growing period. It is cultivated to some extent in every rice growing country, although in aggregate the areas under upland rice are far less than those under swamp rice. Little attention has so far been paid to its production and improvement, but in view of world rice shortage it appears to merit study. This subject is down for mention at the forthcoming meeting of the International Rice Commission. We are indebted to FAO for the following account of the crop and its problems.

STRICTLY speaking, it is difficult to find a satisfactory basis for distinguishing upland rice from lowland rice. Generally, lowland rice refers to rice grown on low-lying areas where water can be collected and retained by artificial irrigation, rainfall or a flooded river to keep the soil constantly submerged at the appropriate growing period of the crop. Upland rice refers to the rice crop grown on higher lands, hill tops, hillsides or areas where neither irrigation nor any water-retaining device is available. It grows and matures with the rain just like other dry land crops.

In certain countries in the tropics the rice grown is chiefly the upland type. In the major rice-producing countries, however, upland rice occupies only a small percentage of the total area under rice. Because of its relative unimportance in comparison with lowland rice, reliable information on its production is seldom available and experimental work on its improvement has not been extensively carried out. In view of the constant food shortage in the major rice-consuming countries during the post-war years, however, the improvement of upland rice may prove to be a means of increasing food production wherever facilities for successful cultivation of lowland rice cannot be readily made available.

Varietal improvement

All varieties of upland rice have a shorter maturing period than lowland rice. As a rainy season crop in tropical countries they usually mature in three to four months, while in a temperate region their growing period may extend to as long as six months.

The yield of upland rice is always lower than lowland rice. On an average upland rice is reported to yield only 33%-37% of lowland rice in North Borneo, 39% in Japan, 51% in Formosa, and 63% in upper Burma. While certain varieties of upland rice can be grown under wet conditions with increased yields, it is not possible to grow lowland rice in upland form of culture without sacrificing yields considerably.

Varieties of upland rice are usually coarse and bold grained and have red kernels. Although they are not necessarily inferior to lowland rice in nutritional value, they are of lower grades in marketing. Exceptionally, certain varieties of upland rice may possess very good quality. For instance, the Nakorn Patom hill rice in Thailand is well known for its taste, flavour and cooking quality which are unequalled by any other varieties in that country.

Improved varieties of upland rice are not generally available as rice breeding so far has been carried out chiefly with lowland rice. The varieties grown in most countries are still unselected, or even mixed. To start a breeding programme, a survey of the local varieties appears to be necessary. While it is possible to obtain strains of higher yields and better quality simply by selection, it may be desirable to hybridise the upland type with the lowland type in order to introduce certain characteristics into the latter to meet the preference of local consumers.

In addition to yield and quality, drought- and disease-resistance should be included as important objectives of breeding. Although certain major diseases attacking rice, such as *Helminthosporium* spots and 'blast,' are known to damage upland rice, other diseases may become prevalent with the extension of upland rice.

Rotations

In the cultivation of upland rice rotation is the exception rather than the rule, especially in tropical regions. Usually rice follows rice successively every year, often in mixture with other crops. This is chiefly due to a preference for rice over other crops, as it is the most important staple food for local people.

Although continuous cropping of rice is a regular practice in lowland culture, it is undesirable for upland rice. After growing successively for a few years, the yield of upland rice is subject to a down trend. In Japan, the Tochigi Agricultural Experiment Station in Kanto District, where 67% of the acreage of upland rice in that country is grown, has carried out an experiment comparing the successive cultivation of upland rice with upland rice rotated with soybean. At the seventh year the yield of rice in the rotating plots was about twice as high as that in the successive plots. Average yields for seven years were 15.9 bushels and 12 bushels per acre for the rotating and successive plots respectively.

Even in the few places where rotation is practised with upland rice, no definite scheme has been followed and many variations occur, depending upon the climate and local cropping conditions. Two countries, Japan in the temperate region and Indonesia in the tropics, will be taken as examples to show the rotation systems in use for upland rice.

In Japan, when rotation is adopted, upland rice is grown in every two, three, or rarely four years, with the following as the representative patterns:—

Type	*First year*	*Second year*	*Third year*
Two-year rotation	Rice—barley or wheat	Soya bean—barley	
	Ditto	Sweet potato—barley or wheat	
Three-year rotation	Rice—barley	Soya bean—barley or wheat	Taro—barley or wheat
	Rice—barley or wheat	Hercules' club—barley or wheat	Ditto
	Rice—wheat	Sweet potato—naked barley	Soya bean—millet—naked barley
	Rice—barley	Soya bean or red bean—millet—rape	Sweet potato—wheat

Rotation schemes involving four or more than four years are also practised in Japan, but only in the truck crop belts or in areas where soils are extremely poor. In the latter case the restoration of soil productivity may be attempted by leaving the land vacant or to become naturally reforested, but such practices are adopted only on rare occasions.

In Indonesia the general rotation scheme for upland rice is as follows:—

First year: Wet season, rice; dry season fallow.

Second year: Wet season, various crops such as maize, manioc, peanuts, legumes, vegetables. If the soil fertility is reasonably good, another crop, such as cowpea or other legumes, is sown before the dry season. If the soil is poor, no crop is grown at all in the second year. Dry season, fallow.

In order to preserve soil fertility and reduce weed growth, it is important to devise a rotation system in upland rice areas, based on results of trials under local conditions. A rational system is to include, when weather conditions permit, a green manure crop sown immediately after the harvest of the main crop or during the dry season. In the following year a crop other than rice which permits thorough weeding or, by the nature of its growth inhibits the profuse development of weeds, should be planted. Local cropping practices should be given as much consideration as the natural environment conditions in devising a rotation system acceptable to growers.

Soil erosion

In the primitive form of upland rice culture the crop is grown on land newly cleared from the jungle. In these undulating areas, when the forests and undergrowth have been cleared, soil erosion usually becomes a serious problem, particularly where the rainfall is high. Tillage and other cultivation measures usually accelerate erosion and run-off and the land soon becomes unfit for cultivation. Occasionally efforts are made to protect the slopes against run-off by placing long branches in such a way as to follow the contours, but these are hardly effective. Even in the more permanent form of upland rice culture, if no special attention is paid to conserve the soil the land frequently has to be abandoned after a few years. Since upland rice is usually grown on slopes of undulating areas, measures for the prevention of soil erosion should receive special study. The common measures such as terracing, contour-cropping and strip-cropping, etc., give good results.

Mechanisation

In the growing of upland rice under shifting cultivation very often no implement is used except a pointed stake for making holes for sowing. Hardly any effort is made to cultivate the land.

Even in more permanent types of cultivation only very simple implements are used in most countries. The preparation of land is done by means of a wooden or iron plough, and weeding by a hoe. Inadequate preparation of the land results in a proliferation of weeds, and consequently lower yields.

Where upland rice is grown in a manner similar to other cereals, and under conditions favourable for mechanisation, the experience of other countries should be sought. The recent efforts in Ceylon, Thailand, Malaya and the Philippines in mechanising rice culture undoubtedly should be of considerable value in this connection.

Complete mechanisation, of course, is not easily achieved and cannot be attained in a short time. The gradual introduction of suitable implements could increase the efficiency of land preparation, sowing, cultivation and harvesting. The transition from primitive methods to a mechanised form of rice culture, however, involves many problems which must be considered in relation to local conditions.

Weed control

One of the characteristic features of upland rice culture is the abundance of weeds. These greatly affect the yield, and their eradication is costly. Most of the common synthetic herbicides known today cannot be used for controlling grass weeds in rice fields without causing injury to the crop, and very few rice-growing countries are familiar with control of weeds by chemicals. To solve this problem, extensive experimental work will be needed. In the meantime, the introduction of suitable rotations and inter-cropping systems coupled with weed eradication by mechanical means will have to be relied upon to reduce the damage caused by weed infestation.

Manurial practices

The soils under upland rice are usually poor in fertility and the land may even have to be abandoned after a few years' cultivation, as in the case of cleared jungle land. Manuring is seldom and usually insufficiently practised, especially in the tropical regions. It is essential in any programme for the improvement of upland rice that investigation of manurial requirements be carried out to suit the local soil conditions, and on this basis a proper manuring schedule introduced.

Gambia Rice Farm Examination

The Colonial Development Corporation stated in its annual report for 1950 that it did not propose to go ahead with a large-scale irrigation scheme for rice cultivation in the Gambia until results in a pilot area had shown this to be economically possible.

The Corporation has now sent a mission of independent experts to Gambia to examine and report on the work so far carried out and to investigate the most advantageous methods of future development. The mission will consist of Mr. A. Gaitskell (leader), Brigadier C. G. Hawes, Mr. D. Rhind, Mr. H. MacLuskie and Mr. J. D. Gillespie (secretary).

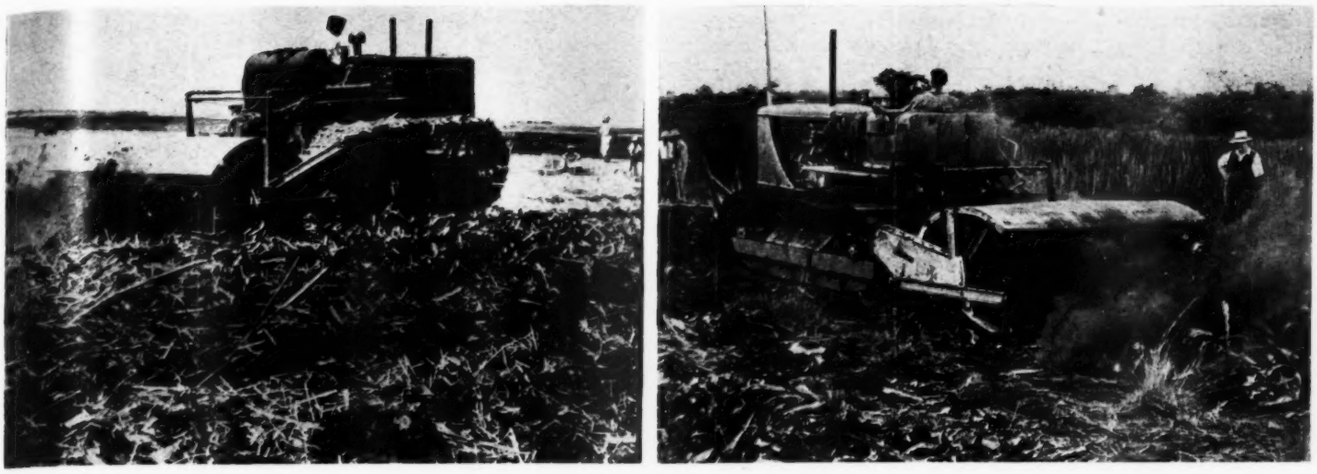
Mr. Gaitskell is managing director of the Sudan Gezira Board; Brigadier Hawes, irrigation consultant, is Hydrological Adviser to the Government of Uganda; Mr. Rhind is Secretary for Agricultural and Forestry Research, West African Inter-Territorial Secretariat; Mr. MacLuskie was principal agricultural officer in Sierra Leone until 1951; and Mr. Gillespie is a member of the Colonial Development Corporation agriculture division. The mission left by air for Gambia in mid-February.

The sum of £1,115,000 was sanctioned for this scheme in February 1950; since that time about £300,000 has been spent on the construction of irrigation and drainage works. The pilot area is about 4,250 acres.

WORLD CROPS

OUR NEXT ISSUE will include an account by E. J. H. van Sluis of the work that is being carried out at Eindhoven, in Holland, on the **Irradiation of Plants with Artificial Light.** John Grindrod writes about **Grain Production and Storage in the Argentine** and describes the extensive large-scale grain handling plants which have been installed in that country.

The Oil Industry will be the subject of the fifth article of the current series, **Industry's Contribution to Agricultural Research,** describing the work of fighting pests and diseases which is being carried out by the Royal Dutch/Shell Group of Companies in their laboratories in the U.S.A., Britain and the Netherlands. Other articles and regular features will appear as usual.



Howard rotavator (*left*) turning in sugar cane trash on a sugar estate in India and (*right*) clearing old sisal boles in East Africa

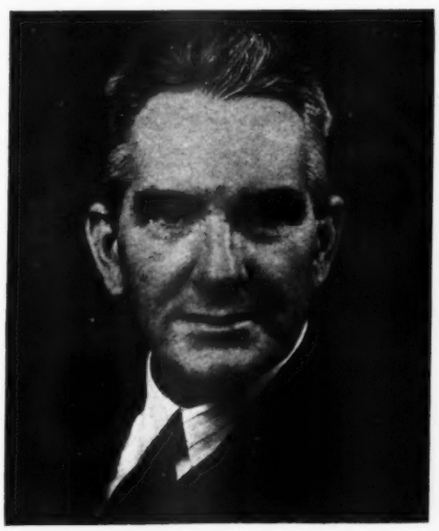
INDUSTRY'S CONTRIBUTION TO AGRICULTURAL RESEARCH—IV

The Development of Rotary Cultivation

Rotary Hoes Ltd. and the Howard Rotavator

A. C. HOWARD

Managing Director



A. C. Howard, Australian inventor of the Howard Rotavator. His first rotavator was marketed in Australia in 1923

Of late years attention has been drawn towards rotary cultivation, particularly in its tropical aspects. This article, the fourth in our series, describes the evolution and development of rotary cultivation by Rotary Hoes, Ltd.

BRITISH exports in 1951 included more than 13,000 Howard Rotavators. These rotary cultivating machines went to Australia, the Americas, South Africa, New Zealand, India, Pakistan, Europe—in all to some 68 countries. The uses to which they have been put range from normal cultivation of the soil to specialised work in forests, in wet paddy fields, and on sugar estates. The demand for rotavators continues to outstrip the supply and it is small wonder that journalists are finding it fashionable to describe Rotavation as 'the new revolution in agriculture.'

Origin of the Rotavator

Most of the progress made in the theoretical and practical development of modern rotary cultivation dates from the invention of the rotavator. The first rotavator, made and marketed 29 years ago, was the outcome of research into the putting of power *direct* to the work of tilling the soil.

This problem of using power direct had challenged agricultural engineers for many years. It was recognised that the business of transforming engine power into draught for pulling drawn implements involved a serious power loss and many were the unsuccessful attempts to invent a machine that would eliminate the loss and put the power thus saved into the land.

I began studying the matter about 1910, with the aid of my father's steam tractor and a rather Heath Robinson experimental rig. As time went on, my experiments covered every type of tilling blade and tool I could devise. I tried propellor-shaped blades on latitudinal shafts, all sorts of tines on vertical shafts, and many tines and forms of blade on transverse shafts.

Many early rotary tillage implements had failed because they relied on spring tines and high rotor speeds which led inevitably to over-pulverisation of the soil. This over-pulverisation, fatal to correct crumb structure, had in many countries given rotary cultivation a bad name that could not be redeemed until it was proved beyond doubt that rotary tillage could give a correct and controlled tilth, with soil crumb structure preserved.

The rotavator had therefore to be different, and after much experiment and test it emerged as an implement with a comparatively slow rotor speed, driven direct from the tractor power take-off, and with hoe-blades instead of the familiar tines.

The hoe-blades

Many people still take the hoe-blades of the rotavator for granted. There is at least one case on record of a farmer getting his local blacksmith to make him a new set of blades only to realise, when they gave short-lived and unsatisfactory service, that there was more in the rotavator hoe-blade than met his casual glance.

The rotavator blade is more than a simple L-shaped piece of steel. It was designed to give the greatest effect for the smallest use of power. Its cutting edge, strong enough to resist stones and like obstructions, is forged and ground to deal

effectively with weed growth, green manure crops, trash and soil. Its back is carefully sloped away from the cutting edge to prevent a rubbing action on uncultivated soil which would cause power wastage. In action the blade lifts, breaks, loosens and aerates the earth, and then returns it with the finer particles underneath a coarse, protective topsoil. There is no danger of over-pulverisation or excessive breaking down of soil aggregates, because the whole process is under such complete control.

Development of rotary tillage

This method of tillage, which we now call rotavation, and the principles upon which it is based are sufficiently familiar, I imagine, to need no discussion here. The fact is that the rotavator has become a valuable and sought-after implement for normal cultivation. It can be, and is, widely used as a tool for the complete cultivating cycle, but in Britain it is frequently used in conjunction with the plough, for many farmers have found that this partnership of new and old gives the best results for British climatic and soil conditions.

The success of the rotavator can be measured by the growth of Rotary Hoes Ltd., which began at Horndon, Essex, in 1938 with scarcely a handful of men and which, despite the intervention of the Second World War, is now a prosperous company with subsidiaries at home and overseas and a world-wide distributor organisation. Expansion continues as rapidly as present-day conditions permit. The factory at Horndon is still receiving substantial additions, and during the year past, a second distributing company has been formed in the U.S.A., and a manufacturing company in France.

Development has not been limited to providing rotavators for all leading makes of tractor and hand-controlled machines for small farmers and growers. The rotavator principle has also been applied to special work and cultivation. Reports from our field representatives and co-operation between user and manufacturer have led us to evolve important variations of the standard hoe-blade and rotor for work in pastures and paddy fields, forests and sugar-cane estates. A recent highly successful application of the rotavator principle is seen in the haulm pulveriser which has reduced the potato grower's spraying and lifting costs and given him increased tonnages, in some cases of as much as 10%. Development of this kind owes much to the reports of our field representatives and of distributors selected to test prototype models, and to co-operation between the user and the factory.

Some of the rotavator's most fruitful success is found in those parts of the world where tropical and sub-tropical crops are grown widely. Of particular importance is the use of the rotavator as an implement for mechanised wet paddy growing.

Rotavation in rice cultivation

Rice is the chief food crop of more than half the world's population. More than 60% of the total world rice production is by the wet paddy method. Hitherto that method has been based upon primitive, peasant-farming techniques as old as time itself, albeit sound enough in principle. Faced with war's aftermath of devastation and with rapidly rising populations, the rice-growing countries are abandoning the crude traditional methods of cultivation in favour of mechanisation. No less important in increasing the yield of rice are new strains of this cereal and improved methods of irrigation; but mechanisation remains a major step towards economy of labour, efficiency of tillage, and the cultivation of much wider areas.

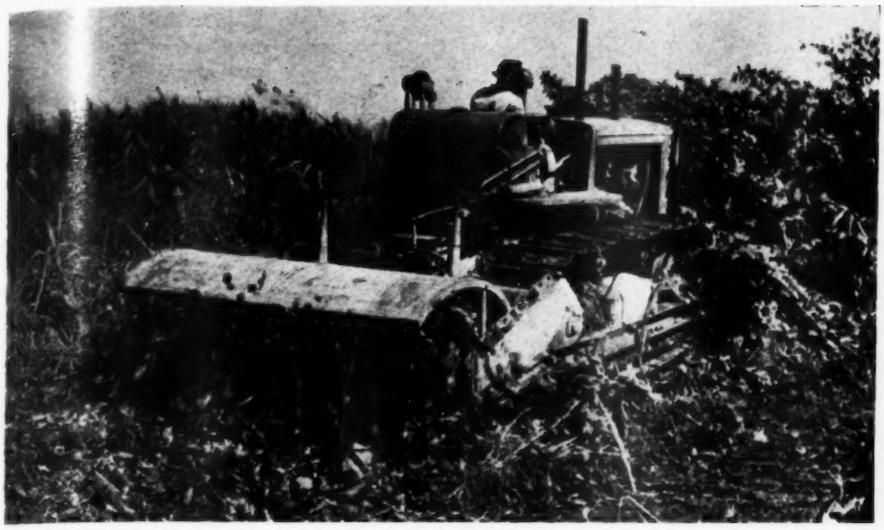
The need for a special wet paddy rotavator was at once brought home to us when we first introduced our hand-controlled machines in the Far East. The result was the small, hand-controlled wet paddy 'Gem,' powered by a 6 h.p. engine and equipped with large skeleton wheels and special steering brakes, which rapidly won favour on the small peasant holdings so general in the rice-growing areas. Pictures of this machine at work in Trinidad, Malaya and Siam have appeared already in WORLD CROPS.

More recently tractor-powered rotavators, with a standard cut of 50 in. and a cultivating depth of up to 9 in., have been demonstrated in India with such success that there is every sign that the rotavator will become the standard implement in large-scale wet rice growing. The rotavator tractor attachment works in the wet paddy fields without any wheel slip, turning in the rice straw, green manuring and preparing the land for transplanting. When demonstrated at Mankhurd, near Bombay, the rotavator finished an area of about half an acre in three-quarters of an hour. The quality of the job done was excellent, resulting in a perfect mixture of soil. The soil was thoroughly worked to a depth of 7 in., burying all weeds, and the consistency of the mud was uniform throughout. This makes it possible for the transplanting job to be done even six to eight days after cultivating as the mud does not dry up which is the normal disadvantage in the case of bullock ploughing. The rotavator has been adopted with enthusiasm by the Government of Madras, whose Minister of Agriculture, Mr. A. B. Shetty, stated at a press conference in July last: 'A tractor with a rotavator attachment is the best answer to the demand for machinery for wet cultivation.'

The growing of rice is now being developed in France in the Camargue, where stock rearing was formerly predominant. Here the largest rotavators are to be used in conjunction with the French ADN 61 and 70 tractors.

In Zululand, South Africa, swamp and marsh reclaimed by rotavator are now yielding crops of a special '90-day' rice developed by Mr. Gaspar Szokolay, the rice expert of the Swaziland Irrigation Scheme of the Colonial Development Corporation.

As a 'stubble-buster' in Suffolk. Here rough cultivation was achieved at the rate of 3 to 3½ acres per hour



Rotavator heavy-duty attachment clearing black sage and guava in British Guiana

The Howard rovatator working in wet paddy in India

The same machine as in the picture above, showing arrangement of hoe blades

Sugar cane cultivation

Rotavators, both standard and heavy-duty types, are in general use in the sugar-producing areas of the world. They perform two major tasks in the cultivating process; ratooning, which is virtually a pruning of the stools after the harvest, and —also after the harvest—the chopping up and turning in of cane trash and the old, tough, fibrous stools which have outlived their usefulness. Special ratooning rotors with a central gap about a foot wide and a variety of cultivating widths are used.

The rotavator as an implement for the disposal of cane trash was described recently in the *Times of India* as ' the answer to every sugar farmer's prayers.' In India trash is usually removed to compost pits beside the field, or spread manually and ploughed in, or gathered and burned. Where ploughing is carried out, the ridges are first broken down with a heavy Athens harrow with cut-out discs, and then ploughing, discing and ridging follow in that order. The quick mechanised disposal of trash by the rotavator thus effects a substantial reduction in cultivation costs, and at the same time increases soil fertility for the new harvest by putting the chopped up trash where it will form valuable humus. The following is a report from the *Times of India* on a demonstration of this work on the Laxmiwadi Estate of the Godavari Sugar Mills, near Kopergaon Ahmednagar District: ' the rotavator went over a field covered thickly with trash. After one operation a good amount of trash had been chopped up and buried, while after a second cross operation 70% to 80% of the trash was turned in. The soil was well mixed with trash, ridges were broken and levelled, roots cut and thrown up. The cultivation depth was between 6 and 8 in. Under average working conditions one acre or more can be worked in one hour. A special feature of the demonstration was when the rotavator ripped up with ease the outer bunds of sugar fields, removing the obstinate roots of " shevri " trees, usually planted as windbreaks. Normally, heavy rooters or rippers are used for this work.' According to Mr. P. M. Govitrikar, manager of the Somaiya Farms, the removal of the shevri is of considerable importance, for this tree is a favourite breeding ground of the ' grasshopper ' sugar-cane pest. The heavy-duty rotavator used for this particular demonstration is now being tested by the Central Tractor Organisation of the Government of India (described in WORLD CROPS last month) as a tool for the eradication of kans grass.

Land reclamation

The rotavator has been no less successful in land reclamation. Bog, marsh, heath and gorseland have been reclaimed with the rotavator which has also shown itself well able to tackle tough jungle growths such as black sage and guava. There is mounting evidence to show that the rotavator can eradicate bracken, but tests are not yet complete and it is too early to claim that the rotavator is the complete answer to stubborn infestations of this growth. What can be said is that test plots near Muirkirk, Ayrshire, cleared by rotavator during trials organised by the Scottish Machinery Testing Station at Calder have been re-seeded and have so far remained free from bracken; further observation of these plots this spring will show whether or not eradication is permanent. Last year a special high-speed rotor was used on a bracken test plot at Muirkirk, but here again it is too soon to report results.

Forestry

The heavy-duty rotavator recently underwent a series of trials for the Forestry Commission. The testing was severe, but the conclusions reached by the conservators were highly flattering to the machine—' a very desirable piece of equipment to have at one's disposal—one is tempted to say an essential piece of equipment.' The rotavator was considered especially suitable for six classes of forestry work: active surface cultivation for purposes of afforestation; clearing and cultivation of most types of scrub areas; cultivation of rides as fire breaks; cultivation of ' those areas where suppression of weed growth such as bracken is desirable ';

Rice Research in India

ELEVEN research schemes, initiated and financed by the Indian Council of Agricultural Research on rice, were in progress at different centres during 1950-51. Seven of these were on breeding and agronomy, three on pests and diseases, and one on manurial requirements.

Over three decades ago, in Bengal, rice breeding was initiated on a scientific basis. Today, besides the Central Rice Research Institute, which is under the Union Government, some 40 stations run by the States carry on research schemes on rice breeding, according to an account by the Indian Council of Agricultural Research which appeared in the *Tea and Rubber Mail.*

The Central Rice Research Institute maintains a collection of nearly 3,000 genetic stocks and a search is being made in this collection for high-yielding varieties suited to local conditions, a search that has been rewarded by the emergence of promising strains now under yield tests.

The problem of rice breeding, so far as India is concerned, is complicated by enormous variations in the life periods of rice varieties grown, from 80 days to seven months and more. Earliness in yield is an extremely desirable quality if such earliness does not cause loss in productivity.

Research has shown that, with rare exceptions, foreign varieties of rice are not so satisfactory for direct cultivation in India. The exceptions that occur belong to some of the varieties introduced from China. These have proved particularly suitable for the Kashmir Valley, where they have yielded 400 lb. of grain or more per acre, and have now become the standard varieties for the area. These Chinese types mature in 90-100 days in the plains and in 120-125 days in the Kashmir Valley owing to the cooler climate. Another foreign variety on which research is in progress comes from Russia, the desirable feature of which appears to be earliness—a factor of some value in hybridisation.

A typical scene in the wet rice growing areas of the world—primitive ploughing by oxen

The hybridisation project, now in progress at Cuttack, seeks to cross the tropical rices with those of the sub-tropical and obtain from the progeny types combining the useful character of both for growing under tropical conditions. More than anything else, these processes are expected to give early maturing types with good yields.

Intensive hybridisation of Japanese and Indian varieties of rice is in progress under two separate projects.

Besides these, an intensive programme of hybridisation is being attempted within the Indian group for evolving high-yielding, early-maturing types.

By a special technique evolved at the Central Institute the status of the improved varieties of the Indian types for susceptibility to two important diseases has been investigated. In Madras selection of natural types, not previously dealt with, has given two varieties suitable for various areas in the State, and they are expected to serve an area of nearly 1,000,000 acres. Work has been taken up for breeding varieties suitable for altitudes of 3,000 ft.

The work on hybridisation is increasing rapidly. Yield per acre continues to be the main objective in this programme, but emphasis is being laid more and more on improvement of characteristics besides yield, like varying life periods, resistance to disease, floods, salinity in the soil, and earliness.

Where irrigation facilities exist for a period of eight to nine months, experiments at the Central Rice Research Institute have shown that it is quite feasible to grow in the same year either two crops of rice and a green manure crop, or a jute crop and a rice crop with a green manure crop in between.

Development of Rotary Cultivation—*Conclusion*

converting heathland to nursery; and as 'an *in situ* mixer for road construction purposes where cement stabilisation is considered advisable.'

Conclusion

Cement stabilisation is not the only quasi-industrial or industrial use to which rotavators are being put. Much could be written of their work in gas purification processes, in sewage disposal, in gold recovery operations in South Africa, in chalk excavation, and in road scarification for retread surfacing operations. But these novel and still largely unexplored applications do not come within the scope of this present article.

What has been written shows clearly the multi-purpose nature of the rotavator and the place it has won for itself in world agriculture. The rotavator has done more than provide farmers with a new and better means of doing old jobs. Its very nature compels them to question ways and beliefs of husbandry that have ruled for a thousand years and more. Itself the product of research, the rotavator stimulates new research into the whole business of cultivation.

A centrally-mounted rotavator working with a Ferguson tractor equipped with Howard reduction gear (final drive ratio 3 : 4 : 1) in India just before the monsoon

Principles of Low Volume Sprayers

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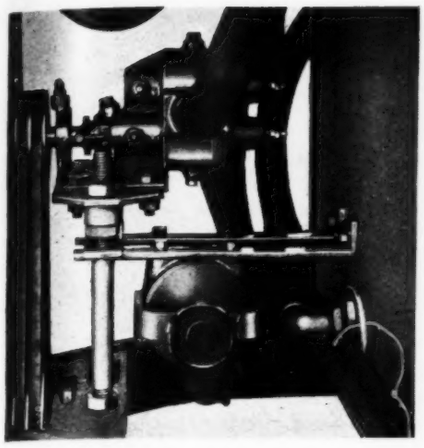
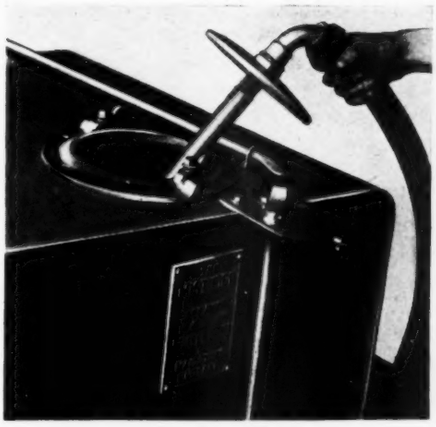


Gear-type pump with tractor power take-off, used on the Mistifier crop sprayers

The increased selectivity of weed-killers, the labour saving and comparatively low capital outlay for low-volume sprayers have popularised a new and rapidly-growing movement in weed control. This article describes the components of low-volume spraying machines and their principles of operation.*



Self-filling tank on the Mistifier; suction pipe with lid and strainer allows visible filling

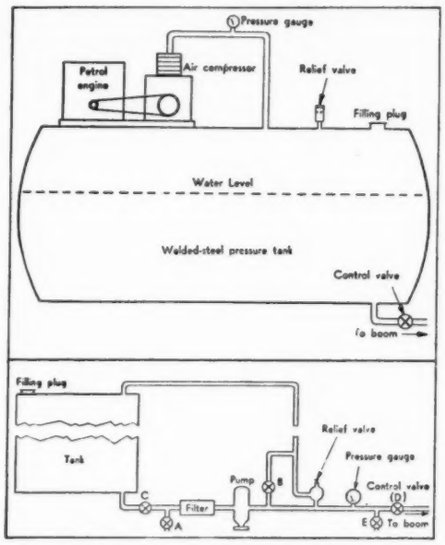
THE low-volume sprayer consists essentially of a boom fitted with special low-volume nozzles to which the spray material is delivered at a low pressure—usually about 30 lb./sq. in. The material may be delivered through hoses to the boom in either of two ways: it may be forced from a sealed vessel by compressed air or gas, or it may be pumped from an open vessel.

Air-compressor machines

Though a low-volume sprayer incorporating an air compressor is much more expensive than that using a pump, a farmer who can make good use of the compressor outside the spraying season would do well to consider it fully before making a choice.

The sprayer using this system of pressurising the material consists of a compressor (driven either by the tractor or by an independent engine) which delivers compressed air to a sealed tank fitted with a large filler plug at the top and an outlet at the bottom from which the spray material is led to the boom. If the compressor lacks a check valve, one is fitted in the air line between the compressor and the tank. A relief valve and a pressure gauge can be fitted either in the air line or on the tank. A filter and a control valve in the spray line between tank and boom complete the outfit. The tank must be of welded construction to withstand pressures up to 100 lb./sq. in. The boom fitted to this type of sprayer is identical with that fitted to the pump type.

COMPONENTS OF LOW-VOLUME SPRAYERS



The top diagram shows the layout of an air-compressor type of low-volume sprayer. Below is a diagram showing the layout of a standard low-volume machine incorporating constant-flow pump and extra fittings; A is a valve on the suction hose to the water supply and E a valve on a side line to a hand boom. To fill tank, A and B are opened and C, D, E closed; for spraying A and B are closed and C, D, E opened

The tank is about three-quarters filled, the filler plug screwed down to be airtight, and the air compressor set in motion. Excess air pressure is released through the relief valve after the desired pressure has been obtained. The liquid in the tank takes up the same pressure as that shown on the gauge, and opening the control valve releases it to the boom at this pressure.

Pump-type sprayers

The standard low-volume sprayer using a pump consists essentially of a tank, a filter, a pump, a relief valve, a pressure gauge, a control valve, and a boom in that order, the distance between the units being variable to suit circumstances, but the relationship of one unit to another being fixed. The units are connected by pipe fittings, pipe or hose as is necessary.

The tank

Any container or combination of containers which will hold the required quantity of spray material may form the tank, and usually one or more 44-gal. drums are used. They should be clean and rust-free inside and arranged so that each is filled through the large bung. The liquid is usually drawn off from an outlet welded to the bottom of the drum, for this facilitates drainage after the unit has been washed down after use. The overflow from the relief valve is returned to the drum through the small bung at the top, and this overflow is sufficient to keep the spray material mixed. No external or mechanical agitation is needed, for modern weedicides either form a true solution in water or are so finely divided that the particles do not have time to settle between refills of the sprayer.

The filter

Though only clean, pure water must be mixed with the concentrate for low-volume

* Condensed from the *New Zealand Journal of Agriculture*, September 1951.

spraying, a filter between tank and pump is essential to ensure that no abrasive material enters the pump to score it and lower its efficiency. Fitting a gauze filter either in the filling funnel or in the mouth of the filling plug of the tank is a good idea, but a filter should also be placed in the line from tank to pump to make doubly sure that no abrasive material enters the pump. A gear pump, which is almost universally used in this type of sprayer, relies on clearances of the order of thousandths of an inch between the body and the rotors for its pressure and volume output. Any abrasive material entering the pump would destroy these fine clearances and impair the efficiency of the pump.

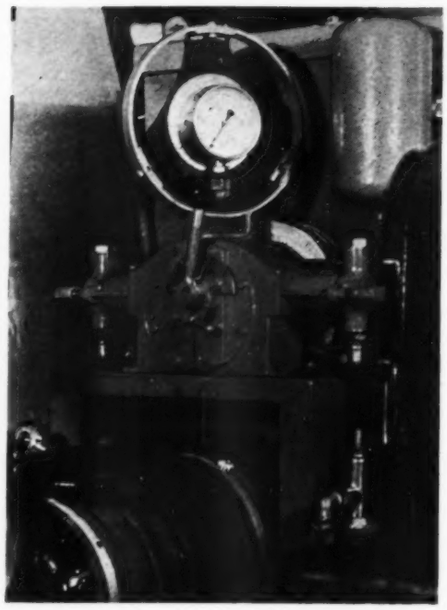
Whatever type of filter is selected the gauze should be as nearly non-corrodible as possible (brass or monel-metal wire is recommended) and of 120 to 150 mesh per inch so that it will hold up the smallest particle likely to block the fine orifice of the smaller low-volume nozzles. Some nozzles incorporate a fine-mesh filter, but it is best to rely on these filters to pick up only material sloughed off from the rubber hose and pipe between pump and boom and to depend on the main filter to do the major work.

Type of pump

Being the prime mover in this type of spray equipment, the pump is all-important. Any type of positive-displacement pump with sufficient delivery and pressure will do, but a centrifugal pump is unsatisfactory because, in general, though this type has adequate delivery the pressure developed rarely reaches 15 lb./sq. in.

The rotary-gear type of positive-displacement pump is most favoured, being inexpensive and very efficient for its size and cost. It is available in two types: in one the gears run externally to each other, and in the second one gear runs inside another. Gear pumps depend for their delivery on the peripheral speed of the rotors and on the width of the face of the rotors; variations of either or both give different deliveries from different sizes of pumps. They depend for pressure on fine clearances between rotors and pump body. Different sizes of gear pumps are known by the size of the pipe fittings which they are tapped to receive; a ½ in. gear pump is tapped to take ½ in. piping.

The average gear pump as used in water-supply systems is quite suitable for being built into a low-volume sprayer. It is designed to be run at 400 to 500 r.p.m. (unless the manufacturer recommends otherwise) and, as the power take-off shaft of a tractor turns at about 535 r.p.m. at rated engine speed, this pump can be coupled directly to the shaft.



Twin-piston pump of the Whirlwind Professor combined dusting and spraying machine. Cylinders are porcelain-lined, providing a variable volume of liquid from 0-15 pints per minute

Alternatively, the pump can be driven from the tractor belt pulley and by choice of pump pulley the pump revolutions can be increased to give greater output and pressure. This is sound within reasonable limits, for though the life of the pump is reduced proportionately, its low cost makes the replacement of the pump a few years earlier of little importance. On the whole, however, if increased output is required, it is best to fit a pump of the next greater size.

Size of pump

Allowing a fair margin for return of overflow to the tank for mixing purposes, for long usage (pump delivery decreases with wear), and for the fitting of larger nozzles to the boom, the ½ in. pump is suitable for sprayers with 8 to 10 ft. booms, the ¾ in. pump for 10 to 12 ft. booms, the 1 in. pump for 12 to 15 ft. booms, and the 1¼ in. pump for booms 18 ft. and longer. All sprayers fitted with a self-filling device need a 1¼ in. pump to reduce filling time to the minimum.

Relief valve

To obviate the pump delivering to the boom more spray than is required and at a higher pressure than is needed a relief valve is fitted into the line from the pump to the boom and excess liquid is returned to the tank through a separate line. A relief valve consists of a housing containing a valve held on its seat by a spring, the tension of which is adjustable externally by a threaded stud. Liquid in the spray line above the desired pressure lifts the valve off its seat and the excess flows through the relief valve to be collected and returned to the tank to act as an agitator and be used again.

In general, the relief valve chosen should have a spring designed for 50 to 60 lb./sq. in. so that slackening the stud bearing on the spring gives pressures as low as 20 to 25 lb. and tightening gives pressures up to 100 lb. The average low-volume sprayer works at a pressure of 30 lb./sq. in. A relief valve with an external adjusting stud should be chosen.

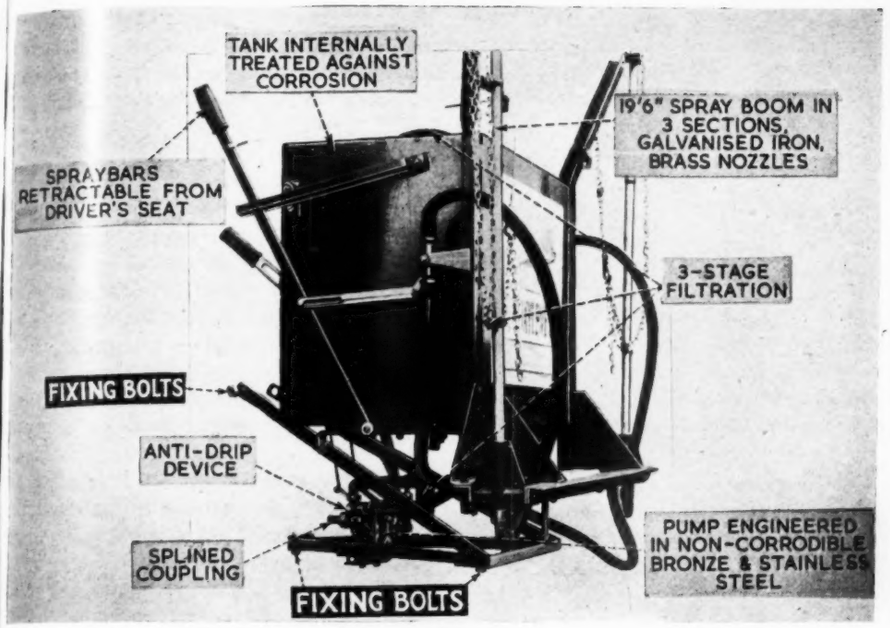
A special gear pump designed for use with low-volume spraying plants has a relief valve built into the end plate so that it releases excess pressure from the outlet port of the pump and returns the excess spray material to the inlet port. With such a pump a relief valve on the spray line from the pump to the boom is not necessary.

Pressure gauge

A pressure gauge should be fitted in the spray line between pump and boom in a position where it is readily seen by the operator.

Its face should be 3 to 4 in. in diameter so that it can be read at a distance from the sprayer—for example, by an operator using a hand lance on 30 ft. of hose for spot spraying or cleaning up awkward corners. The gauge should read from

Close-up of the main nozzle of the Whirlwind atomiser sprayer. The main carrying air stream travels up the outer concentric tube and carries the atomised liquid in a vertical throw of spray of up to 50 ft.


TANK INTERNALLY TREATED AGAINST CORROSION
19'6" SPRAY BOOM IN 3 SECTIONS, GALVANISED IRON, BRASS NOZZLES
SPRAYBARS RETRACTABLE FROM DRIVER'S SEAT
3-STAGE FILTRATION
FIXING BOLTS
ANTI-DRIP DEVICE
PUMP ENGINEERED IN NON-CORRODIBLE BRONZE & STAINLESS STEEL
SPLINED COUPLING
FIXING BOLTS

Tractor-mounted low-volume sprayer showing external features

0 to 100 lb./sq. in. in 2 lb. steps so that pressures can be set and maintained accurately.

Control valve

Delivery of the material to the boom is controlled by a valve fitted in the spray line, between tank and boom in a compressor-type machine and between pump and boom in the pump type. The valve can be of the instant shut-off type with which a quarter turn closes or opens the valve, as in quick-acting valves or gas-main cocks, or of the type that is slower in action and is screwed down or up as in gate valves and bib-cocks. In general, the gas-main cock is not recommended, for after a short period of use it develops wear and leaks spray material.

The control valve should be within reach of the operator; if that is not possible, an extended control rod operating the valve should be brought within his reach.

Booms

Essentially a straight tube to which the nozzles are fitted, the boom should be of sufficient diameter (generally 1 in. to 1¼ in. for long straight booms and ½ in. to ¾ in. for short lengths as are used in articulated booms) to ensure that the spray material is fed evenly to all the nozzles and that pressure does not drop. It may be built from standard galvanised-iron piping, from steam pipe, or, if resistance to corrosion is desired, from brass or copper tubing.

A new polythene plastic tubing which resists corrosion by both acids and alkalis offers great possibilities for boom and spray-line construction and undoubtedly will be more widely used in this field. It is available in standard pipe sizes and can be cut and threaded similarly. By the use of a stream of hot nitrogen two lengths of the plastic can be welded into a continuous length or into a T.

The boom may be made in one straight length or in three lengths hinged together to form an articulated boom that folds upward or backward for transport on roads or through gates. It may be constructed so that it will fold back on impact with an obstruction such as a fence post and not be damaged and will be returned to its working position either by a spring or gravity. Its height should be adjustable to allow for different heights of crops sprayed either by its being clamped to posts at different heights or by a system of ropes and pulleys.

Nozzles

Nozzles should be screwed into sockets bronzed directly on to the bottom of the boom, into an inverted U tube, or into a side elbow bronzed on to the boom; the first fitting is used almost universally. The socket is usually of brass and, as the nozzles are also brass, a brass-to-brass fitting is obtained that makes for easy removal of the nozzle and minimum damage to the thread.

With the realisation that the large quantity of water in a weak solution of weedicide acted merely as a spreading and dispersing medium the way was opened for low-volume spraying, and the development of the low-volume nozzle in the U.S.A. in recent years made the system possible. The only essential was that the required quantity of active weedicide had to be spread evenly over the area, and when that could be accomplished with small quantities of water at low pressures there followed a great saving in capital outlay on plant and in time and work needed for spraying. Whereas previously large quantities of water had to be hauled to and sprayed over fields at rates as high as 100 gall. per acre, weeds could now be eradicated by spraying a concentrated solution of weedicide at rates as low as 2 to 5 gal. per acre. In practice, rates of about 10 gal. per acre are used for weeds in crops and pastures.

Because of its accurate machining the low-volume nozzle at low pressures delivers through a fine orifice a spray of small particles of relatively even size and density in the shape of a fan or a solid or hollow cone as desired. That most widely used for weed control in pastures and crops sprays in the shape of a fan.

Spray control

The nozzles are made of brass, and a nozzle of any one make has a range of tips of different deliveries which are interchangeable, enabling any desired spray pattern or rate of spraying to be obtained by merely changing the tip in the nozzle. Increasing the pressure in the boom increases the rate of delivery from the nozzles, and the pattern of spray alters because the particles become smaller and more finely divided. The finer spray is more subject to wind drift and less able to penetrate into herbage, so the rate of application should be increased by changing to a larger tip. The largest tip gives a spray containing large particles and is suitable for spraying into herbage where deep penetration is desired, but as coverage of the herbage is reduced, alternating large and small tips across the boom and operating at higher pressures has been found effective; the larger tips give a penetrating spray while the smaller give a fine, fog-like spray that swirls into the herbage to complete the coverage.

Most low-volume nozzles incorporate a filter to prevent the fine orifice becoming blocked with material suspended in the spray. The filter is removable for cleaning, and the fine gauze is usually made of a non-corrodible wire such as monel metal.

Some nozzles also have a non-drip valve, which usually consists of a spring-loaded, stainless-steel ball bearing in contact with its valve seating; the spring usually allows the valve to open at a pressure of 10 lb./sq. in. for spraying at normal pressures, but when the boom control valve is closed the nozzles continue spraying until the pressure in the boom drops to 10 lb./sq. in.,

when the valve closes to prevent nozzle drip and keeps the boom full of spray material until it is used again.

Spray lines

Filter, pump, relief valve, pressure gauge, and control valve are usually built into a compact unit by the use of pipe fittings.

The spray lines connecting the tank to this unit and the boom can be built up from standard water pipe or ordinary garden hose, either rubber or plastic, as desired; all will withstand a pressure of 100 lb./sq. in, which is about the highest used in a low-volume sprayer. Hose is useful if the spray line must be taken round awkward corners. Constriction in the spray line must be avoided, as it will reduce the flow and pressure of the spray material. The usual cause of constriction is the use of hose adapters when changing from pipe to hose in the spray line, especially where the hose is $\frac{1}{2}$ in. plastic. A larger hose slipped directly over the pipe is better than a hose adapter or fitting; $\frac{3}{4}$ in. hose fitted over $\frac{1}{2}$ in. pipe or 1 in. hose over $\frac{3}{4}$ in. pipe makes an efficient joint that offers no obstruction to the flow of spray material. Loss of pressure in the short spray line used will be negligible if $\frac{1}{2}$ or $\frac{3}{4}$ in. fittings are used.

Other fittings

The pieces of equipment discussed are the essential parts of a low-volume sprayer, but the machine may be improved and made more efficient by the addition of one or more of the following fittings.

Hand boom

For spot spraying weeds where they are so sparse as not to warrant the use of the big boom fitted to the sprayer a hand boom will be found very useful. It can also be used for spraying drain banks, under fences, around sheds, and in awkward corners where the big boom cannot penetrate, and for treating brush vegetation which is too high or irregular for the normal boom. A hand boom on a long hose can be used for cleaning up patches of weeds on steep faces inaccessible to the tractor.

The hand boom consists of one, two or three nozzles fitted to a cross-head or straight head, which is mounted on a straight length of piping usually of $\frac{1}{4}$ or $\frac{3}{8}$ in. diameter for lightness. A length of hose carries the spray material, the supply of which is controlled by a valve. By fitting a T in the spray line between pump and boom and sealing this side line with a stop-cock, a permanent fitting is made for the hand boom, which can be used at will without interference to the big boom.

The 'Tee Jet' nozzle, showing component parts, commonly used for low-volume spraying

Self-filling device

If two tanks are fitted to the sprayer to reduce travel for refilling when spraying fields distant from the water supply, filling two 44-gal. drums by hand will be found arduous and time-consuming. The sprayer may be made to fill itself by fitting a hose to a side line on the suction side of the pump and a line by-passing the relief valve and controlled by a stop-cock to deliver the water to the tanks.

The sprayer is usually fitted with a larger pump to reduce the filling time. A $1\frac{1}{4}$ in. pump delivers about 300 gal. per hour and will fill two 44-gal. drums in about 15 min. Under average spraying conditions two 44-gal. drums will carry enough material to spray 8 to 11 acres non-stop before refilling is needed.

Speedometer

A tractor-mounted low-volume sprayer operating on level fields will maintain a fairly constant speed because of the self-governing motor, but on rolling country engine revolutions will fluctuate as the machine goes uphill and downhill, with corresponding changes of speed. This leads to fluctuations in the amount of material sprayed per acre and perhaps to the difference between a partial and a complete kill. Under such conditions, and especially when the sprayer is fitted to a vehicle, such as a farm truck with a non-governed engine, a special low-reading speedometer is an invaluable aid. The average car or truck speedometer is not accurate in its lower ranges, but speedometer specialists can make at reasonable costs special units for tractors which are accurate up to 10 m.p.h.

With accurate control over speed and pressure, an operator has accurate control over the amount of material sprayed per acre and under suitable conditions can reduce the amount of active ingredient and still obtain a complete kill. The resultant saving in cash will soon pay for the speedometer. Though $\frac{1}{2}$ lb. of 2, 4-D acid equivalent per acre is usually recommended for killing wild turnip and fat hen, under favourable conditions and in the seedling stage they can both be killed with $\frac{1}{8}$ lb.

RATED DELIVERIES OF LOW VOLUME NOZZLES IN COMMON USE IN NEW ZEALAND

'Agroxone' Nozzles: Delivery at 4 m.p.h. and Pressure of 30 lb. per sq. in.			'Tee Jet' Nozzles: Delivery at 4 m.p.h. and Pressure of 40 lb. per sq. in.			
Jet	*Delivery per nozzle (gallons per hour)*	*Spraying rate per acre for a boom with nozzles spaced*	*Tip No.*	*Boom height*	*Distance apart of nozzles*	*Gallons per acre*
		12 in. apart / *18 in. apart*				
'Agroxone' jet ..	4.51	9.6 / 6.4	650067 ..	18 in.	18 in.	5.0
217/00	8.16	17.28 / 12.1	65015 ..	18 in.	18 in.	10.7
217/0	13.15	28.1 / 18.74	6503 ..	18 in.	18 in.	21.4
			730077 ..	20 in.	20 in.	5.0
			730154 ..	20 in.	20 in.	10.0
			730308 ..	20 in.	20 in.	20.0
			8001 ..	17 in.	20 in.	6.4
			8002 ..	17 in.	20 in.	12.8
			8004 ..	17 in.	20 in.	25.6

'Monarch' Nozzles: Delivery per Nozzle in Gallons per Hour

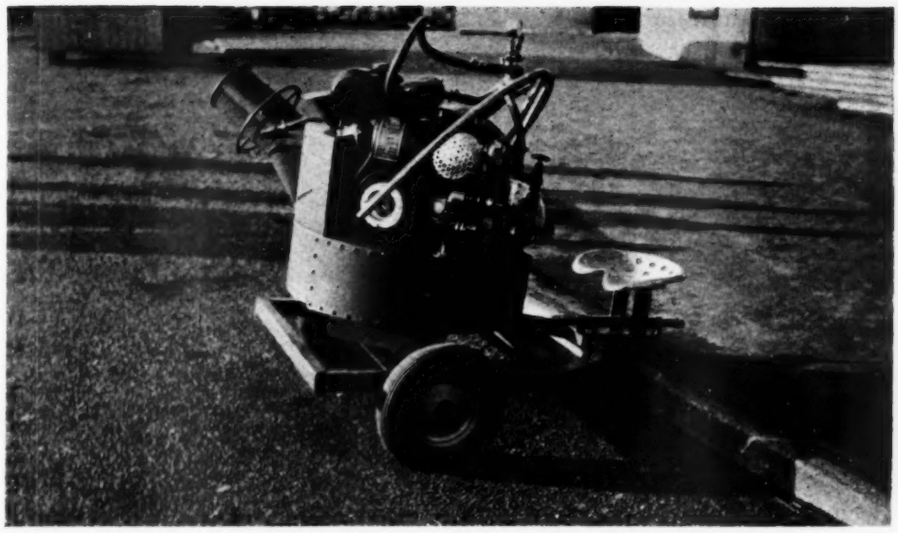
70° *fan tip*	*Pressure in lb. per sq. in.*						
No.	20	25	30	40	60	100	200
20	—	—	1.75	2.55	3.1	4.0	5.75
22	—	—	2.9	3.35	4.15	5.25	7.6
25	3.2	3.4	3.8	4.25	5.3	6.75	9.65
28	3.4	3.9	4.15	5.0	6.25	7.75	11.3
32	4.9	5.25	6.0	6.5	7.55	10.0	15.0
35	6.0	6.6	7.15	7.9	10.0	12.5	17.5
39	7.6	8.8	10.0	11.3	14.15	18.3	36.1
46	10.0	11.25	12.5	13.8	16.65	21.65	31.65
59	17.5	20.0	22.5	25.0	30.8	40.0	55.0

with a saving of about 7s. 6d. per acre. Sufficient would be saved on a 20-acre field to buy the speedometer necessary for such fine work.

Special booms

If the main boom is made in three parts which fold for road travel or negotiating obstacles, it is sometimes useful to have the spray line to the boom split with a cross into three separate lines, one to each section, and each line controlled by a stop-cock, the whole boom being controlled by a master stop-cock in the main line. This arrangement enables the operator to shut off delivery to the centre boom and one outer boom and, by driving along a drain bank, to spray only the weeds in the drain with the outer boom.

Photos: P. 141, Drake and Fletcher Ltd.; P. 142, Universal Crop Protection Ltd.; Pp. 143 and 144, Pest Control Ltd.; P. 145, Clean Crops Ltd.



Standard Micron sprayer mounted on a trailer as an orchard sprayer. Mist blowing in orchards has proved to be very successful, particularly in Holland

Base Exchange in Soils

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IT is just over 100 years ago, in 1850, that the Royal Agricultural Society of England published two justly world-famous papers announcing that soils had the power of absorbing bases such as ammonia and potash from their salts, so preventing them being washed out of the soil by rain after their salts had been added to the soil as manures. The first paper was by H. S. Thompson,[1] later Sir H. S. Meysey Thompson, a founder and a President of the Society, who described the original experiments made at his suggestion by Joseph Spence, an apothecary of York, in 1845. The second paper was by J. T. Way,[2] the Society's consultant chemist, who started working on this problem in about 1848, after Thompson had told him about his discovery. Way, being a chemist, realised its scientific implications, and in a series of three papers elucidated the fundamental facts so clearly that for the next 60 years little more was added to this subject, and these papers have become one of the classics of agricultural chemistry.

The basic experiment made by Thompson and Way was to percolate a solution of ammonium sulphate or of ammonia through a soil and to analyse the solution that first drained out. They found that in the former case it was mainly calcium sulphate, and in the latter nearly pure water. Way, in particular, thus established the two main points of ' base exchange,' as this phenomenon soon became called: that the basic part of neutral or near neutral salts percolating through a soil in solution will exchange quantitatively for some of the absorbed bases held by the soil, but that the power of the soil to hold these bases will increase if the base itself, or a basic salt, *e.g.* ammonium carbonate, is percolated through. He also found that the power of a soil to hold ammonia, lime, magnesia and potash in this way is greatly reduced if the soil is ignited, and he suspected that it was connected in some way with the clay fraction in the soil.

Cation exchange

In the first place the name of the phenomenon has been changed from ' base exchange ' to ' cation exchange,' because it has long been known that the basic part in potash, for example, is not the potassium part of the molecule; hence it is wrong to speak of potassium as a base. It is part of this archaic chemical language to express the potassium content of a fertiliser as its content of K_2O, even if the fertiliser contains no oxygen at all. In present-day chemical language, the base potash consists of a cationic part—the potassium cation—and of a basic or anionic part, and the phenomenon of base exchange involves the laws of exchange between cations. Hence the new name. Prof. W. P. Kelley of the University of California has recently published a book entitled *Cation Exchange in Soils*,[3] which can almost be regarded as the centenary memorial to J. T. Way, as it contains an excellent account of the historical development of the subject, written in a language readily understandable by all who have a moderate knowledge of chemistry.

The problems

The problems fall into three parts: what part of the soil is responsible for cation exchange, how are the exchangeable cations held on this substance and what are the laws governing the intensity with which individual cations are held, and how do the exchangeable cations held by the soil affect the properties of the soil and the composition of the crop growing in it? The answer to the first problem is now known: part of the organic matter and the clay minerals are responsible for cation exchange in most soils, though in a few there are other silicate minerals besides the clay that can take part.[4] Yet, although this sounds very obvious now, it is only in the last 20 to 30 years that it has become generally accepted, for it had to wait until the general theory of the constitution of the clay particle was fairly widely accepted. The answer to the second part—how clays hold the cations and the laws of cationic exchange are still only incompletely understood. We probably know how clays and organic matter hold the cations—the clays largely because they are so constituted that they carry a negative electric charge which must be neutralised by positively charged ions, and these are the exchangeable cations; and the organic matter, and the clays to a lesser extent, because they can be true acids since they possess hydrogen ions—the cause of acidity but also cations—which are replaceable by other cations.

The practical reasons for the importance of base exchange phenomena are always increasing. On the soil side, there is a

group of problems concerning saline soils, with particular reference to the quality of irrigation water, a second concerning the use of salt or sodium nitrate as a fertiliser, and a third the reclamation of land flooded by sea water. It has been known for a long time that soil may be very difficult to cultivate if sodium forms too high a proportion of the exchangeable cations, and present experience indicates that, in the absence of free salts, this will occur if sodium forms more than 15% of the exchangeable cations and that considerable care is needed if it forms between $7\frac{1}{2}$% and 15%.

Sodium salts in irrigation water

The first group of problems concerns the proportion of sodium salts that are allowable in irrigation water without the soil coming to harm, for nearly all water contains some sodium salts, and some contains fairly large quantities. In the present state of the world's food supplies, it is essential, in some areas, to use all available water provided it will not actually ruin the soil, and it has become of great importance to predict if a given sample of water is likely to be dangerous to use, so that proper precautions can be taken at the outset to minimise the risk.

The use of nitrate of soda

The second group of problems, very closely related to the first, concerns the possible dangers of using agricultural salt or nitrate of soda on soils. In many textbooks the statement is made that adding a sodium fertiliser must increase the proportion of exchangeable sodium ions in the soil with consequent danger to the soil tilth. But this need not be correct, for it is the same question as the use of water containing sodium salts. The proportion of exchangeable sodium in the soil does not depend on the amount of sodium ions percolating through the soil, but on the ratio of the amount of sodium to other ions, and in particular to calcium. Provided the ratio of sodium to calcium ions in the soil water falls within certain limits, the exchangeable sodium content of the soil will remain within safe limits however much of the solution leaches through. Hence provided the calcium content of the soil is maintained, and the dressings of sodium salt used are not excessive, one can use sodium fertilisers indefinitely without harming the soil, as in fact has been done for nearly 100 years on some Rothamsted plots with sodium nitrate. Repeated very heavy dressings of sodium salts can naturally harm the soil structure. Thus at Rothamsted 2 tons of sodium chloride per acre, given over a period of eight years as dressings of $7\frac{1}{2}$ cwt. and $3\frac{3}{4}$ cwt. in alternate years, has made the tilth lumpier and stickier though without affecting the germination or stand of either sugar beet or barley, the two crops grown on this land, or apparently without making a seedbed more difficult to prepare.[5]

Reclamation of sea inundated land

The third group of problems concerns the reclamation of land flooded by sea water and it became of great practical importance in 1945 in parts of Holland, Belgium and France after the Germans had evacuated many areas flooded by the sea. Suitable dressings of calcium sulphate, or gypsum, applied to the land after the salt had begun to wash out, allowed calcium to replace much of the exchangeable sodium in the surface soil before all the salt had gone, so preventing the soil from becoming undrainable and uncultivatable, and allowing cropping to begin almost immediately after reclamation had started.[6]

Mineral uptake of crops

Another example of the relevance of base exchange in agriculture is the attempt to predict the mineral composition of a crop growing on a given soil, for uptake of potassium, magnesium, calcium and possibly some trace elements can be looked on as an example of base exchange between the soil particles and the plant roots, for these nutrient ions principally exist in the soil as exchangeable ions. Hence the proportions of the various exchangeable cations in the soil has a direct and perhaps a controlling effect on their proportions in the plant; and if the proportions of any two in the plant leaves are too large or too small, crop growth will be unduly limited on the one hand, and the feeding value of the crop, particularly to livestock, will be unduly low on the other. It now seems possible, under certain conditions and for certain crops, to predict the approximate mineral composition of the leaves of a crop from a knowledge of the relative activities, which is not quite the same thing as the relative proportions, of the exchangeable ions in the soil.[7] The relative activities have been determined by such devices as leaching the soil with a very dilute acid solution, so that only a small fraction of the total exchangeable ions are displaced, and estimating the ratios of the different cations in the solution. If these methods are found to be valid it should help farm advisers to make more accurate predictions of the exact effects of adding fertilisers on the mineral composition of the crop, and so on the extra yield to be obtained, and of any harmful secondary effects which may be produced by their use, such as for example, the inducing of magnesium deficiency in herbage through a too generous use of potassic fertilisers.

(*From the 'Journal of the Royal Agricultural Society of England,' 1951, Vol. 112.*)

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New Chairman for Pest Control

A recent photograph of Lord Boyd-Orr

Lord Boyd-Orr, D.S.O., F.R.S., has accepted the Chairmanship of Pest Control Ltd., in succession to Sir Guy Marshall, who has relinquished his Chairmanship of the Company for health reasons.

Sir Guy was founder and first director of the Imperial Institute of Entomology from 1913-1942, and has been Chairman of Pest Control Ltd. since it was founded in 1939.

Lord Boyd-Orr is known best of all for his work as Director-General of FAO. He was awarded the Nobel prize in 1949. He has for some time been interested in the application of science for the control of plant pests and diseases.

A Director of the Clydesdale Bank and the North of Scotland Bank, Lord Boyd-Orr farms himself on a considerable scale and has devoted his life to a study of world food problems.

NEW BOOKS

Advances in Genetics

Vol. IV illustrated. Edited by M. Demeric. Pp. 343, Academic Press, New York, 1951. $7.50.

Today, even the specialist has difficulty in keeping abreast with the wealth of papers published on the genetics and breeding of plants and animals. *Advances in Genetics*, devoted wholly to authoritative reviews, plays a valuable part in helping to reduce to less intractable proportions the abundance of facts and theories appearing in an ever-increasing number of scientific journals and reports and in many languages. Volume IV maintains the high standard set by previous issues. It contains nine papers, of which four deal with certain crops.

C. A. Krug and A. Carvalho survey the genetics of coffee, mainly with reference to investigations at the Instituto Agronomico, Campinas, Sao Paulo, Brazil. They report substantial progress in the analysis of the heritable variability, cytology and mode of reproduction of *Coffea arabica*, the species cultivated in Brazil, and in the study of other forms. Since 1932 at the Institute the findings of this basic research have been used in planning the breeding programme; some of the hybrid types developed may be economically valuable.

T. R. Richmond contributes a paper entitled 'Procedures and Methods of Cotton Breeding, with special reference to American cultivated species.' The emphasis is laid on the breeding of Upland varieties (*Gossypium hirsutum*) in connection with problems of cotton production in the U.S.A. As in other countries, development of the characteristics required in future varieties, such as special fibre properties, suitability for mechanical harvesting, and resistance to drought, diseases and pests, is being attempted in two ways: much more sensitive methods of selecting within current varieties and within straight and back-cross hybrids; and introduction of new genes, by hybridisation with primitive indigenous stocks of *G. hirsutum* from Mexico and Central America, and with other species. In interspecific crossing, breeders in the U.S.A. and elsewhere are finding the colchicine technique invaluable in inducing fertility in hybrids normally sterile, by doubling of the chromosome number. A particularly interesting line of research in the United States is study of the possibility of exploiting hybrid vigour, an attempt no doubt partly stimulated by the spectacular success of hybrid maize. Commercial utilisation of high-yielding hybrids is, however, seriously handicapped by the difficulty of producing first generation hybrid seed on a large scale since, unlike maize, cotton is a self-pollinated crop: the most hopeful technique is probably use of male sterile 'mother' plants, as in the production of hybrid onion seed.

The genetics of cotton also forms part of the subject of S. G. Stephens' paper on the possible role of genic duplication in evolution, at present a highly theoretical topic. The genetics of many characters in rice, some of which are of direct economic significance, is surveyed by S. Nagao. This summary refers mainly to Japanese work which, except in scattered and unrelated abstracts, has hitherto been relatively little known because of the formidable language barrier.

THERESA ASHTON.

The Polished Ploughshare

How Far Can Science Help the Farmer? By Syd Fox. Pp. 91. Thrift Books, London, 1952. 1s.

Here is a book, written primarily for the townsman, explaining present-day trends of science as applied to farming in this agricultural revolution in which we live today.

The author, a lecturer in the faculty of agriculture at Reading University, has set out in this little book to show how agricultural production has been stimulated in the last decade or so by the entry of applied science. The book discusses in turn the effects which have been shown in improved soil conditions, crop and animal husbandry, plant and animal breeding, housing of livestock and farm management; the idea has been to stimulate the layman's interest towards further reading in these various subjects. Not that this book is in any way sketchy; on the contrary, the thoroughness with which Mr. Fox covers his subject in the confined space at his disposal and the clarity of his prose are to be commended.

The chapter on Science and Crop Husbandry, for instance, covers all the processes from preparing the seed bed to harvest, storage and preservation, including such deviations as the pros and cons of ploughing and rotary cultivation, the technique of manurial experiments, the importance of chemical poisons and chemistry of ensilage.

This is not an agricultural text-book but a concise acount of present-day farming methods which will be read with pleasure and profit by those both in and out of the world's primary industry.

Industrial Fibres

A summary of production, trade and consumption. Pp. xx and 128. Commonwealth Economic Committee. H.M.S.O., London, 1952. 5s. 6d.

The Commonwealth Economic Committee's annual review, *Industrial Fibres*, brings out the fact that in 1950-51 the increase in world production of fibres was very slight, but usage rose sharply. There was, therefore, a marked reduction in stocks by the end of the season, while fibre prices rose to record heights in the spring of 1951.

In the current season, however, world production seems to be greater than in 1950-51, while usage, particular of wool, has been substantially reduced. World prices of most fibres have fallen steeply.

Although production of most fibres increased in 1950-51, cotton fell by 10%. This reduced the available supply of apparel fibres by 3% and all but offset the increase of 14% in the production of non-apparel fibres. At the same time the consumption of apparel fibres rose by 14% owing to bigger defence orders and larger civilian purchases. To meet this increased demand world stocks were heavily drawn upon; by the end of the 1950-51 season stocks of cotton and wool in consuming countries were the lowest for many years.

In 1951-52, however, the cotton crop is one of the largest on record and is estimated at 33,000,000 bales. World wool production is expected to increase by a further 1%. Rayon output again showed a marked expansion—now estimated at 12%—in 1951. The 1951 jute crops in India and Pakistan were of near-record size, and it is estimated that world flax and hemp production also increased.

Prices fluctuated violently. Following the rapid rise after the outbreak of the Korean war in mid-1950, it became clear early in 1951 that the next world cotton crop would be much larger and prices fell fairly sharply. Wool prices, which had shown the greatest increase of all, fell even more rapidly; the main reasons were the abandonment by the United States Government of its attempt to build up a stockpile of wool in 1950-51, and strong consumer resistance to high textile prices. Apart from rayon, the prices of other fibres followed a similar trend, though fluctuations were generally less severe.

World trade in fibres increased by 12% in 1950 compared with the previous year, and for the first time since the war was greater than in 1938. The United Kingdom remained the world's largest importer of fibres, and the United States regained its position as the largest importer of wool. Germany and Japan also imported considerably more than in 1949.

In 1950 the Commonwealth produced 98% of the world's jute and 50% of the world's wheat. It also accounted for a higher proportion of world cotton production, 15% against 13%, in the previous four seasons, mainly because of the rise in Indian and Pakistan output. The share in hemp production in 1950, however, fell to 28%, against 30% in 1946-49, owing to the increase in production of the Philippines and other major producers.

A notable feature has been the outstanding increase in rayon production. World output in 1950 was 29% higher than in 1949, while in 1951 it is estimated to have risen by a further 12%. The production of rayon staple fibre has risen more rapidly than that of yarn, the former being used more widely in mixtures with the natural fibres.

Industrial Fibres has been extended this year to include a survey of the newer man-made fibres such as *Ardil*, nylon, *Orlon* and *Dacron*. At present, world output of these is relatively small, but as the countries are taking up this production, they may become in the future of much greater importance.

This review, as with all the productions of the Commonwealth Economic Committee, is extremely informative and will be invaluable to all seeking up-to-date and reliable information.

Farm Incomes

in England and Wales. Farm Income Series Nos. 2 and 3, covering the years 1948-49 and 1949-50, with some references to earlier years. Reports based on the Farm Management Survey. Pp. 66 and 70. Ministry of Agriculture and Fisheries, 1951 and 1952, 6s. each.

The Farm Management Survey in England and Wales is carried out by the Universities and Colleges concerned on approximately 2,900 farms each year, ranging in size from five acres upwards and comprising 72 different areas divided into 11 types of farming. The Survey scheme, as the Introductions to these reports say, '*makes available each year a body of information on the economic and financial conditions of farming, and this information is useful . . . in consideration of problems affecting the whole industry, as for example, when agricultural prices are under review*'.

Each report consists of between 30 and 35 tables giving figures for an identical sample of farms (2,358 in 1948-49 and 2,588 in 1949-50) for the farming year in question and the one previous to it. Taking 1949-50, for instance, it is seen that net incomes were some 10% lower that year than in 1948-49; they rose in the Corn, Sheep and Dairying group only, but fell as much as 26s. per acre in the Heavy Land Arable group. Net incomes for 1948-49, on the other hand, in nearly all type-districts showed a considerable increase over the previous year, which it may be remembered, suffered from the very hard winter followed by flooding in 1947. Farm revenue was found to be generally higher in 1948-49 than the previous year, with the exception of Arable and certain Specialist groups and in 1949-50 this was true of all type groups (except one relatively small Market Garden group). Farm expenditure followed an upward trend, being 10% higher in 1948-49 than 1947-48, and 11%-12% higher in 1949-50 than in 1948-49.

A particularly interesting fact that emerges is that the average net income per 100 adjusted acres for the years 1940-41 to 1944-45 is only two pounds less than the average for the next five years 1945-46 to 1949-50, *i.e.* £465 compared with £467.

These are a few of the general items of information that can be gleaned from these tables. Much more detailed information, referring to a single type-of-farming group, for instance, can be obtained by studying the tables which deal with such subjects as cropping distribution, livestock sales and purchases, expenditure on feeding stuffs, fertilisers, rent and so on.

Each report contains a few introductory pages which interpret very generally the tables that follow. More detailed explanation would be welcome and, perhaps, the presentation of some of the tables in graph or histogram form; for 60-odd pages of closely-printed tables become somewhat of a strain to work through. For those who have the happy knack of being able to extract the relevant information which will be useful to them in particular from these tables, and sift the wheat from the chaff, these reports hold a wealth of information.

New Publications

The following books, published recently, are available from the Book Department, WORLD CROPS, Leonard Hill Ltd., 17 Stratford Place, London, W.1.

A History of Scottish Farming, by Franklin T. Bedford. Illustrated. Pp. 184. T. Nelson. 12s. 6d.

Arizona Flora, by T. H. Kearney, R. H. Peebles, etc. Illustrated. Pp. 1,032. Cambridge. 56s. 6d.

Cotton Year Book, 1951. Illustrated. Pp. 766. Textile Mercury. Manchester. 12s. 6d.

Farm Machinery and Tractors, by R. H. Cochrane. Illustrated. Pp. 184. Whitcombe & T.

Pasture and Fodder Development in Mediterranean Countries. Pp. 178. O.E.E.C. 14s.

Stages in the Evolution of Plant Species, by J. Clausen. Illustrated. Pp. 216. Oxford. 22s. 6d.

Tomato Culture by Modern Methods, by F. W. Loads. Illustrated. Pp. 176. C. A. Pearson. 12s. 6d.

Wool Year Book, 1951. Illustrated. Pp. 616. Textile Mercury. Manchester. 12s. 6d.

The columns of WORLD CROPS are open to correspondence and the Editor welcomes letters from readers supplementing and commenting on articles or on other matters within our sphere. Limitations of space may necessitate the abridgement of letters.

Free FAO Publications

We have received from their headquarters in Rome a *limited* number of FAO publications (in English) for free distribution. They are as follows:

No. 2. Water Laws.
No. 3. Essential Steps in National Agricultural Development.
No. 4. Agriculture in the Altiplano of Bolivia.
No. 5. Mechanisation of Farming.
No. 7. Results of Cooperative Hybrid Maize Tests in Europe, 1941.
No. 9. Land Settlement for Agriculture.
No. 10. Equipment for Cleaning and Grading Grains and Seeds.
No. 11. Report of the First Meeting of the Working Party on Fertilisers.
No. 12. Equipment for the Processing of Tea.
No. 13. Equipment for the Tanning of Hides and Skins.

Readers wishing to avail themselves of this offer should send a remittance of sixpence by international money order for each publication they require, to cover postage and packing, to:

WORLD CROPS (FAO Publications)
Leonard Hill Ltd.,
17 Stratford Place,
London, W.1, England

CONFERENCES AND LECTURES

The Economic Use of Fertilisers

Conference shows Fertilisers still to be Profitable in Spite of High Prices

ALL three speakers at a recent conference organised by the National Agricultural Advisory Service in Bedford, the subject of which was the Economic Use of Fertilisers, were in full agreement that in spite of the higher costs of fertilisers today, their intelligent application still shows profits well exceeding their costs. On the whole, the nation is not using nearly enough fertilisers for full production.

Value of humus

The first speaker was Professor H. G. Sanders of Reading University. He reviewed the present-day use of organic and chemical manures and emphasised the importance of humus in the soil. The most effective way of adding this is in the form of muck; he did not advocate green-manuring or ploughing in of straw. Experiments carried out for 13 years in Norfolk have shown that muck is the most productive of all the different methods of adding humus to the soil, and as this Norfolk experiment continues the differences in yields between the mucked and, for example, green manured plots are widening.

As an alternative to muck, Prof. Sanders emphasised the importance of grass leys. The sub-surface mat of roots amounts to one ton of dry matter per acre per year; and accordingly if the ley is a four-year one four tons of dry matter are added to the soil.

Muck does not, however, replace chemical manures, and the two are complementary to each other. He suggested that with few exceptions every crop should also have its fertiliser application.

Crop responses

Turning to individual crops, he mentioned that time of application is specially important for wheat, early application giving greater tillering and late application giving more grain per ear. He emphasised the importance of a nitrogenous top dressing in the spring, however well the crop may look. Potatoes, besides receiving plenty of muck, should get at least 10-15 cwt. per acre of a compound mixture; some farmers put on 25 cwt. 'Every acre every year' should be the maxim for fertilising grass and 2-4 cwt. per acre of compound should be applied every spring. The increased growth would be noticeable and strip grazing, which is now becoming commonplace among dairy farmers in the U.K., increases the value of grass by 20%-25%. Thus, having gained this increase how can one turn it to good account? Either plough up some of the grass for arable cropping or value it more highly for feeding purposes which might well result in ending cattle cake bills throughout the summer from April to November.

Farmers in Great Britain today spend on the average 25s. per acre on manures. This is too low, and Prof. Sanders suggested that as a rough guide they should spend at least twice the rental value of the land on fertilisers.

Yesterday and today

Speaking on fertiliser practice today and yesterday, Mr. Arthur Tinney, a well-known Cambridgeshire farmer, reminded the audience that in 1920 the price of sulphate of ammonia was £27 per ton, and compounds were extremely expensive at £10 per ton, since in many cases they contained only 2% of nitrogen and 2% potash. He advocated that dressings of up to a ton per acre on potatoes were justified on the right soil, and considered that no one should be satisfied with a crop of less than 10 tons per acre.

In the discussion that followed the subject of spray application of fertilisers was raised which in the case of nitrogen is about two-thirds the cost of nitrogen out of the bag. It was thought that this method is most likely to work best with perennial crops, since effectiveness relies upon the amount of leaf on which the spray can fall; lucerne is most promising in this respect.

Combined drilling and fertilising

The final speaker at the conference was Dr. G. W. Cooke of Rothamsted Experimental Station, who described work carried out there on fertiliser placement. Comparisons of yields of crops which had (*a*) received fertiliser broadcast over the soil, and (*b*) combine-drilled with the seed, had shown that on light land the latter method was definitely more effective for phosphates, but on heavy land there was no appreciable extra response. No extra yields were obtained from combine drilling nitrogen, and dressings of more than 3 cwt. per acre combine drilled may damage germination.

It is now accepted for cereals, however, that 1½ cwt. of superphosphate drilled with the seed gives the same yield as that obtained from 3 cwt. broadcast on the seed bed.

Work on potatoes has shown that fertiliser spread on the ridges, placed at the side of or in contact with the seed tubers, gives about the same extra yield. On the other hand, broadcasting on flat soil before ridging gives markedly lower yields. It has been found, in fact, that to harvest the same yield of potatoes 10 cwt. of fertilisers are needed if broadcast on the flat while only 7 cwt. need to be applied on the ridges.

Fertiliser placement

For practically all row crops it is considered dangerous to drill more than a small amount of fertiliser in contact with the seed. Placement 2 in. to the side of the seed is generally safe, and with sugar beet 1 in. to the side is safe. Contact placement or placement directly beneath are not therefore recommended for the usual 20-in. row crops, and carrots appear to give higher yields if their fertiliser dressing is broadcast. Crops giving definite results from side placement are peas, beans and certain horticultural crops; those which give similar yields from both placement and broadcasting are sugar beet, mangolds, fodder beat and kale.

Regarding machinery for side placement, Dr. Cooke said that so far only prototypes had been made, but it was hoped that the manufacturers would be designing suitable ones in due course.

Summary

Summing up the pros and cons of combined seeding and fertilising in one operation, Dr. Cooke said that the advantages were the labour saved by only having one operation in the field and the reduction of the consolidating effects of continued operations on the land.

On the other hand, there are two hoppers to fill instead of one and a consequently longer time taken turning round at the headlands, while the high cost of and maintenance required by such machines must be justified before purchase can be considered economical.

U.K. Dependencies and World Food

THE contribution of the U.K. dependencies to world food supplies was the subject of a lecture delivered to the Royal Society of Arts in London on January 10 by Mr. C. G. Eastwood, Assistant Under-Secretary of State at the Colonial Office.

People are apt to think of the dependencies as great sources of natural wealth, said Mr. Eastwood, but while they contribute to many of the world's needs of raw materials, they export relatively few basic foodstuffs in any quantity. They export none of the basic cereals, with the exception of a little wheat and maize from Kenya and a very little rice from British Guiana; on the contrary, they are net importers of rice, wheat and flour. They export practically no meat; they consume what meat they produce and could consume more. They export virtually no bacon, butter, eggs or cheese but import several of these things in considerable quantities.

Nevertheless they do have important exports of foodstuffs. The main exports are sugar, vegetable oils and oilseeds. Their sugar exports are now over 1,250,000 tons a year and should soon be 300,000 tons more; they export some 300,000 tons of oils and nearly a million tons of oilseeds and copra. These are very substantial contributions to the world's needs. They also export some bananas and other fruits. The other foodstuffs they export are mostly drinks—cocoa, coffee, tea, citrus juice and rum.

A greater contribution to world food supplies is perhaps the fact that many of the dependencies feed themselves. The 2½ to 3 million people in the West Indies do so only to a small degree, the 9½ million in South-East Asia supply about half their own needs, but the 55 million in tropical Africa are more than self-sufficient in food though often at a poor level of nutrition.

Mr. Eastwood then gave some particulars of food production in the various regions.

West Indies and Mauritius

Sugar production in the West Indies, including British Guiana, is about 900,000 tons compared with 700,000 tons four years ago and may soon be over a million tons. Mauritius now grows 450,000 tons compared with 350,000 four years ago and the limit is not yet reached. The Commonwealth Sugar Agreement guarantees these territories a remunerative market for much of their sugar for at least eight years and it is hoped that it will encourage further increases in production. Excellent work is also being carried on at cane breeding research stations in Barbados and Mauritius in producing canes with a higher yield per acre and a higher sucrose content.

Though these territories are largely dependent on one crop because no other is both resistant to hurricanes and produces so large a return from the limited land, they can materially increase their food production. For instance, British Guiana now grows some 65,000 tons of rice, compared with 25,000 tons 30 years ago.

South-East Asia

Production of rice is also increasing in South-East Asia, where it is of course far away the most important food crop. Before the war Malaya produced some 320,000 tons annually and imported nearly twice as much. Today production is 25% higher and should expand by another 25%. There are plans for the improved drainage of 300,000 acres and for the irrigation of 85,000 acres. Sarawak and North Borneo together produce over 100,000 tons and could perhaps double that amount, which would enable them to export useful quantities to their neighbours.

Other main food exports are palm oil and pineapple from Malaya; in 1950 these amounted to 51,000 tons and half a million cases respectively. The oil palm industry in Malaya is promising and efforts are being made to introduce cocoa into Malaya and Borneo.

Africa

Nigeria exports some 175,000 tons of palm oil and over 400,000 tons of palm kernels annually, far more than any other country in the world. Great pains are being taken to introduce more efficient methods of extraction which would mean a much higher quantity of oil. The Gambia exports some 65,000 tons of groundnuts, and Nigeria, in a good year, over 300,000 tons. These are amazing figures when it is considered that the crop is grown by peasants living 500 to 800 miles from the coast, that exports represent the surplus after local needs have been met and that the crop has to be moved over miles of indifferent roads and tracks and then over hundreds of miles of railway to the port. It is hoped to increase production in Nigeria by the use of phosphatic fertilisers.

Over half the world's supply of cocoa comes from West Africa—some 250,000 tons from the Gold Coast and 100,000 tons from Nigeria. This is the most valuable of all exports from the dependencies, after rubber. The industry is entirely African.

East and Central Africa export less food. Tea and coffee are important but cannot compare with West African cocoa in value. Kenya is now exporting about 40,000 tons of wheat and of maize. Uganda's cotton yields cotton seed, and coconuts are produced on the coast but are mostly consumed locally. Zanzibar's principal export is cloves.

Increasing local food supplies

The possibilities of increasing food production in Africa are still great, said Mr. Eastwood, provided steps are taken to prevent soil erosion, to improve soil fertility and to develop better farming techniques. An immense change could be effected by breeding high-yielding, healthy and disease-resistant strains of food crops.

Four-Wheel-Drive Tractors in the Future?

Speaking on four-wheel-drive tractors at a meeting of the Institution of British Agricultural Engineers recently, Mr. G. R. G. Gates said that as a result of over five years' research and development it is believed that a type of transmission suitable for a laterally rigid four-wheel tractor has been found and at present prototypes ranging in size from 8 h.p. to 100 h.p. are being made.

Mr. Gates traced the development of the conventional two-wheel drive tractor and the tracklayer. He reviewed the progress that has been made with four-wheel drives in France, Britain, the U.S.A. and Germany and said that the characteristics required of the steering system for a laterally rigid four-wheel tractor were now known and these are: that the steering gear must not accelerate the outer wheels of the tractor, nor in operation must it alter the effective overall gear ratio between the engine and these wheels; that it must be fully regenerative and, therefore, employ no brakes for its control; that it must drive the wheels at both sides of the vehicle at kinematic speeds, the ratio of which corresponds to the ratio of inner and outer radii of the curves followed by the inner and outer wheels respectively and as determined by the physical dimensions of the tractor; that it must contain no free differential so that there is no possibility of an unloaded wheel causing any of the other wheels to lose driving power.

ANNUAL REPORTS

Overseas Food Corporation

Report and Accounts for 1950-51

THIS report* covers the operation of the Corporation up to the end of March 1951. We may recall that in September 1949 the original plan was reduced to one for the cultivation of a total area of 600,000 acres divided between 180,000 acres at Kongwa and Urambo, and 480,000 acres in the Southern Province, while the Kongwa Working Party had recommended the reduction of the area under crops there to 12,000 acres. Subsequently it appeared that not more than 150,000 acres of suitable land could be mapped near to Nachingwea, the development base in the Southern Province.

As a result a new plan was presented to Parliament in January 1951 (Cmd. 8125) and adopted. Since the beginning of 1951 the Corporation has operated in conformity with this and at Kongwa in conformity with the recommendations of the Working Party.

Before the 1950-51 planting season agricultural operations at Kongwa were reduced to the four comparatively small farms as recommended. As a result the possibilities have appeared in a more favourable light, thanks to control by experienced farmers and to more favourable seasons.

At Urambo the clearing of the 65,000 acres envisaged was completed under the new plan and 45,000 acres were planted, in the Southern Province; the scope of development was limited to 60,000 acres as a first stage.

Hand labour was largely substituted for mechanical processes in piling felled trees and excavating stumps, but machines continued to be used for felling and root-cutting.

All money granted to the groundnut scheme before 1951 was written off and in future operations will be provided for by parliamentary vote.

Soil conservation

At both Urambo and in the Southern Province land use and soil conservation surveys are considered to have saved much waste of effort in clearing land unsuitable for production.

In the Southern Province a total of some 66,000 acres has now been demarcated as suitable for agricultural development. Soil conservation works reduced the area to about 60,000 acres. A notable advance in demarcation technique has been achieved by improved methods of aerial photographs.

Observations in all regions have confirmed that very serious consideration must be given to losses of soil and plant food through soil erosion. The problem is more acute at Urambo and in the Southern Province, than at Kongwa, owing to the rainfall.

Trials on building terraces with heavy-disc ploughs were made in an effort to reduce costs. At Urambo protection of cultivated land was completed. Protection was given by contour banks, grass strips and contour ploughing and planting. For the construction of contour banks towed graders were found to be superior to heavy-disc ploughs.

Inter-terrace erosion is a serious problem at Urambo and thorough ridging operations must be carried out on all crops.

In the Southern Province soil conservation work was successfully carried out on 7,500 acres under crop. It was found that grass strips were not fully successful though they did in some cases prevent serious erosion.

It seems somewhat remarkable that these conclusions should only have been reached at the present stage, since one would have thought that methods of soil conservation would have been one of the first considerations.

Agriculture

Crop yields in the three areas were as follows:—

	Acres harvested	*Yield in tons*	*Yield per acre harvested (lb.)*
KONGWA			
Groundnuts	7,800	855	244
Sunflower ..	39,600	1,752	99
Maize ..	3,650	1,768	1,085
Sorghum ..	1,000	293	656
URAMBO			
Groundnuts	2,700	640	532
Sunflower ..	8,540	597	157
Maize ..	1,500	364	544
Sorghum ..	100	16	358
SOUTHERN PROVINCE			
Groundnuts	250	77	686
Sunflower ..	220	36	367
Maize ..	210	22	235

In all cases yields are low and appreciably smaller than the original estimate.

In Urambo it became virtually impossible to handle the groundnut crop mechanically and recourse had to be made to hand labour.

Virginia tobacco trials at Urambo gave promising results. Trials with cotton in all three areas showed satisfactory growth, but stainers seem likely to be a serious problem. At Urambo trials with rice gave promising indications.

Research

The director of research resigned in November 1950, and the staff was reduced from 18 to 4. The work of the scientific department was continued on the broad lines laid down previously.

The classification of soil types at Kongwa in the Southern Province was continued. Soil fertility studies showed widespread phosphate deficiencies in the Southern Province and in Kongwa. At Urambo the chief deficiency is nitrogen.

Rosette disease of groundnuts continued to be the most important plant disease studied. Work continued on the biology of the aphid vector and the carry-over of the disease by volunteer plants. Systemic insecticides for controlling the disease were also studied and two of the systemic materials tested prevented the appearance of rosette for over five weeks.

It appears that since the report was written the Corporation has decided to reduce the scale and to revise the organisation of the agricultural research services and in this connection attention may be called to a review of the agricultural research on the Groundnut Scheme by Dr. A. H. Bunting, recently published in *Nature* (Nov. 10, 1951), and which we hope to reproduce in a subsequent issue.

* Pp. 81, H.M.S.O., London, 3s.

Our Contemporaries

Below we list a selection of articles appearing in the April issues of some of our sister journals in the Leonard Hill Technical Group:

Food Manufacture: 'Nutritive Values of Fruit and Fruit Juices' by J. I. Anderton.

Manufacturing Chemist: 'Castor Oil' by C. Griffiths, F.R.I.C. Progress Report on Fertilisers and Plant Nutrients.

Paint Manufacture: 'The Examination of Varnish Making Vegetable Oils' by Dr. H. W. Chatfield.

Muckshifter and Public Works Digest: 'The Lubrication of Earthmoving Machines' by Noel Green.

British Guiana, 1951

IN his address to the Legislative Council recently, Sir Charles Wooley, Governor of British Guiana, mentioned the state of crops and other agricultural matters during 1951.

Sugar production, he said, had lagged behind that for 1950. While this was to some extent attributable to unfavourable weather, there could be little doubt that but for labour disputes and strikes the output for both years would probably have exceeded 200,000 tons. It was high time that an end was put to the contending influences which were dividing and not uniting the sugar workers.

In the case of rice the position was happier. Both in 1951 and 1950 the colony had been able to fulfil the contract with Eastern Caribbean territories and in addition send substantial quantities to Jamaica. Production in 1951 was conservatively estimated at 60,000 tons, and if the plans for water control and the establishment of a Rice Development Company could be brought to fruition, Sir Charles believed a target figure of 120,000 tons to be feasible within the next ten years. The general outlook for the rice industry had greatly improved as a result of the recent award of the Clyde Arbitration Board which would mean an additional income to the colony from its rice exports of over $2,500,000 per annum as from January 1952.

Coconut expansion had been disappointingly slow despite improved prices, the area under cultivation being only 2,000 acres more than in 1946. Had the appeal made at that time met with a proper response, the new trees would have been in bearing next year. Sir Charles hoped for improvement, for the industry was vitally important to both people and livestock.

The banana cultivation experiments under the joint auspices of the Government, Booker Bros. and the Jamaica Banana Producers' Association had given results which warranted their continuation on a larger scale. The same was the case with the jute experiments.

British Guiana Timbers Ltd. were well committed to the Colonial Development Corporation's $10,000,000 forestry project. This was a long-term project, but meanwhile plans were well advanced for systematic large-scale extraction in the area of 500 square miles leased to the company in the Bartica Triangle.

Drainage and irrigation

Both short-term and long-term plans to increase production would be pressed on with as rapidly as possible. Credit from government funds to farmers now stood at a sum of $1,000,000, apart from assistance in many other directions. The Government Marketing Organisation, now handling produce to the value of $1,500,000 per annum, was to be overhauled and strengthened. Some 25,000 acres of Crown lands had been leased at nominal rents and brought into cultivation during the past two or three years. Recent legislation would, it was hoped, make further lands available in the riverain areas for both agricultural and livestock farming. The United Kingdom Government had agreed in principle to a supplementary Colonial development and welfare allocation to British Guiana of approximately £1,000,000 to enable a start to be made with long-term drainage and irrigation measures and to carry out Evans Commission proposals deemed deserving of equal priority. That Government had also undertaken to do their utmost to facilitate the raising of a drainage and irrigation loan of up to £2,500,000 on the London market. The first water control scheme to be taken up, it was suggested, should be the Demerara-Essequibo (now to be called the Boerasirie) scheme. This, commanding a total area of over 130,000 acres, would bring about 50,000 acres of new land under cultivation, provide water for all existing cultivation in the area and, it was hoped, solve the Canals Polder problem.

Which of the other schemes in the overall plan should also be embarked upon must depend in some measure on the response of the Colonial Development Corporation to an invitation to participate with the local government in the establishment of a rice development company. The rice industry would require some $10,000,000 to $15,000,000 of additional capital, a large part of which was needed urgently for new rice mills and to assist rehabilitation of some existing mills. A provisional promise of U.S. $625,000 from Marshall Aid for rice development in British Guiana was bound up with proposals for the Corporation's participation.

(From the West India Committee Circular.)

In British Guiana 82% of the land area consists of largely undeveloped forest—six times the area of the whole British Caribbean

Sixth International Grassland Conference

The U.S. Departments of State and Agriculture and the Food and Agriculture Organisation of the United Nations jointly announce that the Sixth International Grassland Congress will be held from August 17-23, 1952, at Pennsylvania State College, under the sponsorship of the United States Government and FAO.

Approximately 65 countries have been invited by the United States Government to participate and the Organising Committee expects that it will be attended by 2,000 to 2,500 specialists.

The programme provides for the holding of sectional meetings to discuss various major topics relating to grassland.

All inquiries and correspondence regarding the Congress should be addressed to Mr. W. R. Chapline, Executive Secretary, Organising Committee, Sixth International Grassland Congress, Department of State, Room 1049, 1778 Pennsylvania Avenue, N.W., Washington 25.

RESEARCH DEVELOPMENTS

Synergism Between Insecticides

WHEN first applied to insecticides the term synergism was a generic one, and it described those instances of toxic action by a combination of drugs where the pharmacological effect of the mixture was not the simple summation of the individual drugs concerned. Thus synergism covered two aspects of joint action, the one where the drugs opposed each other's action—*antagonism*—when the effect of the mixture was less than summation; the other when the drugs *potentiate* each other and produce an effect greater than a simple summation. As very often used, synergism is now equivalent to potentiation.

Commercial users of insecticides know that the formulation of an insect poison greatly affects its toxicity and there is a large body of laboratory evidence and some good theoretical reasons to support the results of field observation. Recently oily DDT films were demonstrated to be superior to dry crystalline preparations or amorphous films of this poison. Films deposited from solvents that evaporate slowly retain their toxicity longer than those from more volatile liquids. In the same way, too, the efficiency of a wetter, or the fineness of the grind of a wettable powder or the hardness of the inert part of a dusting powder are all factors which affect the performance of an insecticide. These mechanical or physical factors are best distinguished as *activation*; not as synergism.

How synergists act

At present synergist and poison are believed to act together *inside* the insect and to interfere in complementary ways with the physiological processes of the insect. Thus the synergist, *iso*-butyl undecyleneamide, delays the rate of knock-down of *Aedes* mosquitoes by pyrethrum, but increases the kill.[1] This aspect of joint action contrasts with that exemplified by pyrethrum-DDT mixtures, where the pyrethrum does not increase the eventual kill by DDT but merely irritates the insect to scurry about and pick up a larger dose of DDT. In commercial fly sprays, for example, the rapid knock-down caused by the pyrethrum is spectacular proof of its potency.

On the other hand available evidence suggests that piperonyl butoxide and piperonyl cyclonene inhibit the excretion of pyrethrum by poisoned insects.[2,3] Both these compounds prevent the recovery of pyrethrum poisoned flies and the inhibition is almost as great when poison and synergist are applied at different times and at different points on the insect's body, as when they are mixed in the same solution. Moreover, the fact that pyrethrum poisoned flies collapse sooner at 10° C. than at 25° C. suggests that enzymes capable of detoxicating pyrethrum are retarded by low temperatures; if, as is believed, piperonyl butoxide inhibits the action of these enzymes, then flies poisoned by synergist and pyrethrum would not collapse sooner at the lower than at the higher temperature. This expectation is borne out by experimental fact.

Piperonyl butoxide probably inhibits the action of insect lipases. *In vitro* experiments show that extracts of house flies or cockroaches contain lipases, and the addition of piperonyl butoxide to them brings about a 25% to 40% reduction in the rate of decomposition of pyrethrum. Other pyrethrum synergists tested did not affect the rate of decay of the poison in parallel experiments.

Chemical similarities

Synergists of the piperonyl butoxide type appear to share certain chemical similarities. Thus sesamin, safrole, *iso*-safrole and their derivatives, piperonyl butoxide and cyclonene (the latter is really a mixture of two materials) as well as many of the newer synthetic synergists for pyrethrum, contain a chemical group —O—CH_2—O— linked at both ends to a phenyl ring.[4,5,6] The presence of more than one —O—CH_2—O— group per molecule does not confer greater synergistic ability than does a single group; of secondary importance are the >CO and HC=CH groups which appear to enhance the effectiveness of the —O—CH_2—O— radicle. The molecular similarity between pyrethrum and the synthetic pyrethroids explains the observed fact that some of the synergists for the natural poison are also active in the enhancement of the toxicity of the synthetic products.[7]

Molecular similarity between synergist and poison may have a bearing upon their joint action. In an early Geigy patent, DDT was claimed to have been synergised by a number of compounds, many of which, like DDT, possess a pair of phenyl rings with a simple bridge group linking both halves of the molecule. A recent American patent[8] has restated this theme in its claim that 4 chlorphenyl ester of 4 chlorbenzene sulphonic acid acts as a DDT synergist. Similarity of molecular form, although on a different pattern, may also account for the claims of synergism between parathion and its methyl analogue. At comparable doses ethyl 'parathion' and methyl 'parathion' respectively killed 100% and 39% of the test insects. When the poisons were mixed to contain 80% methyl and 20% ethyl analogue and sprayed at the earlier concentration there was, however, complete mortality among the test insects.

It is, however, unwise to push this concept of molecular similarity too far. Thus DDT, aldrin, BHC and TEPP are all synergised by the 4 chlorphenyl ester of 4 chlorbenzene sulphonic acid although there is no molecular similarity between the toxicants concerned.[9,10,11] By the same token there is no evidence to explain the observations that chlordane, nicotine, piperonyl butoxide and cyclonene all synergise rotenone.[12,13]

Need for further work

From the purely biological point of view there are a number of instances awaiting explanation. Work by Meyer and his associates shows clearly that synergism between chemicals is related to the type of insects tested. Thus against the pea aphid and *Plutella* moth, phthalonitrile potentiates the action of nicotine; against *Drosophila* and *Gasterophysa*, however, this nitrile added nothing to the normal efficiency of nicotine. When tested against *Heliothrips*, phthalonitrile actually antagonised nicotine.[14]

Activity of a related kind is noted by Medler and Thompson who found that DDT and sabdilla are mutually synergistic; when they are used against plant bugs the sabdilla appears to be the major toxicant, but when they are used against house flies, DDT is the more important poison.[15]

The wide and frequent gaps in our knowledge of the interaction of synergist and insect poison, must remain until more evidence is available to elucidate the many unsolved basic problems of insect physiology. It is this same ignorance which hampers all the work in the general field of insect toxicology.

ALAN GOODMAN.

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FARM MACHINERY

B.I.F., 1952

Among firms with agricultural interests which are exhibiting at this year's British Industries Fair, to be held from May 5 to May 16, are Messrs. Ransomes, Sims and Jefferies, who will show the small MG5 tracklaying tractor and a selection of ploughs and cultivation implements, including a spray pump with tank. Other exhibitors include Scottish Mechanical Light Industries Ltd., showing hammer mills, the Wolseley Sheep Shearing Machine Co. Ltd. showing their whole range which includes electric fencing, Monsanto Chemicals Ltd. and the Shell Petroleum Co. Ltd. With the exception of the chemical firms, which will exhibit in London, these firms will be at the Birmingham section of the exhibition.

New Hydraulic Dumper

The Thwaites Agricultural Engineering Co. have recently introduced a dumper of 10 cu. ft. capacity, having several unique constructional points. The whole load is taken on the back axle and controlled hydraulic tipping is operated from the driving seat. It is powered by a 5 h.p. 4-stroke Petter engine, giving a top forward speed of 8½ m.p.h. and reverse speed of 4½ m.p.h. There is no gear-box, control being afforded by two 'girling' two-shoe expanding type clutches; foot operated brakes are of the same design. Other details include a low loading height of 2 ft. 6 in., 6-ft. turning circle and a driving seat accessible from either side. The price of this machine is £305.

Protecting the Tractor Driver

Tractor cabs constructed of light alloy extruded sections and sheets are now available for six makes of British tractors. These cabs are designed to protect the driver from rain, wind and, in hot climates, dust and heat. Each cab is fitted with windscreen, side and rear windows; also glazed panels below dashboard level to give the driver an adequate view of the front wheels.

The manufacturers, Scottish Aviation Ltd., make these cabs so that they are easily removable from the tractor. Their price varies around £38, depending on the model of tractor for which they are designed.

Rice Huller and Polisher

A machine which converts paddy to aspirated white rice at the rate of 500-600 lb. per hour is the new Ancomill rice huller and polisher. Although constructed in conventional fashion, various refinements such as a ball-bearing suction fan, fast and loose pulleys and precision ball-bearings mounted in plummer blocks at all rotating parts are claimed to make this a particularly reliable machine. Output of white rice from shelled rice is stated to be between 1,100 and 1,300 lb. per hour, the power requirement being 12-15 b.h.p.

The action of the fan removes both dust and husks in one operation. The machine is manufactured by the Plantation Machinery Department of the Allied National Corporation Ltd.

French Farm Machinery Imports/Exports

During 1951 French exports of agricultural tractors and machinery reached a value of 3,250 million francs, compared with 1,613 million in 1950. This represented 12% of the country's production of 20,500 units (20,861 in 1950). Exports of other agricultural machinery amounted to 6,497 million francs against 3,963 million in 1950. Mexico was the main outlet (ranking only ninth in 1950), followed by Italy, Spain, Brazil, the Argentine, Denmark, Egypt, India and Belgium.

Imports of agricultural machinery in 1951 amounted to 10,319 million francs compared with 9,309 million in 1950. This included 4,308 million francs worth of tractors and machinery against 5,471 million previously, and combine-harvesters from the U.S. and Canada to a value of 3,900 million.

Britain was the main supplier of tractors and motorised equipment, thus regaining the lead lost to Germany in 1950. Germany remained the principal supplier of other agricultural machinery. Other large suppliers were the U.S. and Sweden.

Despite the recent French import cuts, it is believed that imports of foreign agricultural machinery will hardly be affected. The cuts will not affect tractors, which have always been subject to import licensing. Quotas to be fixed for other machinery are expected to be large enough to maintain the current rate of imports, since the Government's agricultural policy favours increased mechanisation and the use of more special equipment in order to cut production costs.

(*Left*) **The Arwell atomising sprayer and duster and** (*right*) **the new Arwell Junior sprayer, described in this page last month. They are products of the R. Wells Agricultural Group, whose overseas distributors are Joseph Pyke & Son (Liverpool) Ltd.**

CORRESPONDENCE

Kenaf and Roselle

TO THE EDITOR

Sir,

In WORLD CROPS No. 2, Vol. 4, I read Mr. Haarer's article on Roselle. In the part about photo-periodicity he writes that Roselle was reported originally to be very sensitive to photo-periodicity, whereas it was discovered later that this refers to Kenaf and not to Roselle. This is quite in contradiction to the results of my experiments with Kenaf and Roselle at Buitenzorg (Java), where I found Roselle very sensitive to short differences in day length and Kenaf wholly indifferent to them. From the references I learn that he missed my publication on this subject which appeared in *Landbouw XVI* (1940) and simultaneously as Medeling van het Algemeen Proefstation voor den Landbouw at Buitenzorg, No. 44 (1940).

In Java we cultivated only *H. cannabinus* and the red and green form of *H. Sabdariffa*. They were grown on soils where they were rotated with wet-rice. Sowing was started at the middle of the dry monsoon, making it necessary to irrigate. When danger was to be expected from infection with Phytophthora and as the spores are carried along with the irrigation water, Kenaf was planted at the entrance(s) of the field as this plant is immune to infection in contradistinction to Roselle. Without infection by this disease, yields of Roselle are much higher than those of Kenaf.

Yours faithfully,

IR. G. G. BOLHUIS.

Landbouwhogeschool,
Wageningen, Holland.
February 19, 1952.

The Author replies

Sir,

Mr. Bolhuis' letter of February 19 has been forwarded to me by the Editor of WORLD CROPS.

It is a fact that the Americans did mistake the Roselle for Kenaf in the beginning. It is also a fact that Kenaf has been found most sensitive to periodicity, and use of this is made in Cuba where later sowings for seed purposes give a stunted growth because the plants flower when the daylight shortens to 12½ hours.

I had suspected that the Roselle might be similarly affected, hence the care with which I worded my paragraph on photo-periodicity.

Concerning the fact that Kenaf did not respond in Java to differences in daylight, I can only suppose that this might have been because of the strain used. Wild mixtures of Kenaf in Africa grow tall on the equator where the hours of daylight are little more than 12. Mixtures north and south are affected by short days, as is most of the material grown in Russia, Cuba, Florida and El Salvador. Material from Korea and Manchuria shows a different response again, and therefore the species must vary enormously in its response to photo-periodicity.

Yours faithfully,

A. E. HAARER.

Sussex,
England.
February 25, 1952.

Note by the Editor

As Cuba lies on latitude 22°-24° N. and Java is latitude 8° S. is it not possible that this may account for the difference observed, since variation in day length in the former place is much greater than in the latter?

Pipeline Protection from Magnesium Anodes

It has long been known that pipeline corrosion results from electrolysis between the metal of the pipe and adjacent soil moisture to a greater or lesser degree depending on the nature of the metal of the pipe and the surrounding soil. Physical protection, as for instance bitumen sheathing, has been used to prevent the early effects of corrosion, but complete effectiveness cannot be obtained in this manner.

The introduction of galvanic or cathodic protection, which operates on the principle of transferring corrosive activity to places where it can be kept under control, is an important advance on former methods, and under average conditions it is claimed that pipelines protected in this way may be expected to have a life of 10 years. Specially designed magnesium anodes have been designed by F. A. Hughes and Co. Ltd., of London. These anodes are connected to the pipe at intervals (six per mile in the average for small diameter pipes) by means of insulated wire and ensure that currents pass from the metal to the soil (electolyte) in one direction only, *i.e.* by way of the anodes, which themselves corrode. The pipe becomes cathodic and incapable of giving up its metallic ions to the earth.

Among the many uses of underground pipelines is that of irrigation for agriculture, and magnesium anodes are being increasingly used nowadays to protect and lengthen the lives of irrigation and drainage pipes.

Hanane in Capsule Form for Gold Coast Cocoa

Speaking at a luncheon in London recently, Dr. W. E. Ripper, Managing Director of Pest Control Ltd., reviewed the progress being made with the systemic insecticide, Hanane, against Swollen Shoot disease of cocoa in the Gold Coast. Hanane is the only known systemic insecticide which kills mealybugs (vectors of the Swollen Shoot virus) and which is also converted to the last molecule into innocuous compounds in the cocoa pod.

Having confirmed the efficacy of this chemical, a practical and foolproof method of application had to be evolved, bearing in mind the scattered nature of the tiny cocoa plantations in the coastal jungle belt of West Africa and the comparative ignorance of the peasant cultivators. A method has been evolved of inserting in the ground, close to the stem of the tree, capsules containing Hanane, which decompose within 24 hours through the humidity of the soil or by water poured on them in dry periods, and release the chemical to the roots of the tree.

The Gold Coast Government has drawn up plans for field-scale experiments and it is hoped that Hanane capsules will soon be used in an area where there is large-scale outbreak of Swollen Shoot. It will be applied by experts to infected trees and those immediately surrounding them. It will not be used on any trees to be harvested for human consumption until the authorities and cocoa manufacturers have further satisfied themselves that no trace of the original toxicity remains in the bean at harvest, and that flavour and keeping quality remain unaffected.

A plant for the production of Hanane is now in operation at Harston, headquarters of Pest Control Ltd., to supply an initial order of £500,000-worth to the Gold Coast Government.

New Fordson Major Successes

We have received a report that the new Fordson Major tractor (vaporising oil model) scored several successes at its first public appearance at the international ploughing match, held in Armagh, N. Ireland, recently.

Using a Ford-Ransome mounted plough the New Fordson Major won both classes in which it competed, the Whole Work Hydraulic Open Championship and the International General Purpose Championship. Entries, besides those from the U.K. and Eire, came from Canada, Switzerland, Holland and Norway.

WORLD CROP REPORTS – THE RICE CROP

WORLD

Rice forecast. The U.S. Department of Agriculture has estimated the 1951-52 world harvest of rough rice at 336,000 million lb., a decline of 1% from 340,000 million lb. in the preceding year. The decline was primarily due to a reduced acreage in the important rice areas of India, the Department said.

In its second forecast of the world rice crop, the Department said rice production in Asia, South America, Africa and Oceania, was less than 1950-51, while sharp increases occurred in North America and Europe.

EAST

The rice harvest in all of Asia would show a decline of slightly more than 1% from the Department's first world forecast made in December 1951. The total harvest was estimated at 309,000 million lb., a decline of 3,750 million lb. from 1950-51, and was due largely to the decline in India's crop and a smaller harvest in the Philippine Republic where prospects were reduced late in the season.

India's acreage showed a decline of 8% resulting mainly from the failure of monsoon rains at the sowing and transplanting time in Northern and Eastern India. But weather was favourable for production in the surplus area of Asia-Burma, Thailand and Indo-China, where the total harvest of that area was estimated at 40,100 million lb. compared with 38,500 million lb. in 1950-51. Burma harvested about 200,000 more acres than in the preceding year with a higher yield per acre than average. Acreage increased in Indo-China, particularly in Cambodia, and there were indications that Thailand also produced more rice than in the previous year.

WEST

All European countries growing rice harvested more last year with the Continent's total production estimated at 3,300 million lb., 400 million lb. or 16% higher than the previous year's crop.

American output at 5,700 million lb. was nearly 700 million lb. or 13% higher than last year. The largest increase took place in the U.S., but production gains were reported in all countries except the Dominican Republic and Guatemala.

Due to mechanisation of rice cultivation in Cuba the Department estimated the crop there at 256 million lb., 53% higher than the previous year.

PAKISTAN

Second rice forecast. The second forecast of the area under rice for the year 1951-52 is 21,487,000 acres as against 21,640,000 acres reported in the second forecast of the previous year and shows a decrease of 0.7%. The acreage reported in the final forecast of last year was 22,401,000 acres. From the past three years' experience it may be stated that the final estimate of acreage is about 4.2% higher than the second estimate.

With the exception of East Bengal (autumn rice), there is a general decrease in the acreage of this crop throughout Pakistan. The decrease in the Punjab is attributed to scarcity of rains and in Sind to inadequate supply of water.

BURMA

Rice production up. Burma's exports of rice during the January-November 1951 period totalled 2,476 million lb. of milled rice, an increase of 3% from 2,397 million lb. during the corresponding period of 1950. November shipments of 132 million lb. were exported to: India 60 (million lb), Japan 19, Malaya 18, United Kingdom 13, Persian Gulf Ports 10, Indonesia 6, other countries 6.

Evidence points increasingly towards a 1951-52 rice crop larger than that of last year. The first official forecast of harvested acreage published on December 8 is 9,583,000 acres compared with 9,264,000 acres in 1950-51, and weather conditions have been more favourable for production than last year.

BRITISH GUIANA

Better rice crop. This year's crop has totalled 62,660 tons, which is 3,480 tons more than last year. Although a record crop, the yield is lower than anticipated.

MALAYA

Rice production. In the season 1950-51, a record total of 442,780 tons of milled rice was produced from 875,390 acres, as compared with the previous highest recorded yield of 435,840 tons from 930,530 acres in the season 1949-50. The high yield is attributed to favourable planting and harvesting conditions.

Before the war local production met about a third of total rice consumption in Malaya, whereas in 1950 it provided 49% of the total consumption. The net imports before the war were, however, about 600,000 tons, while the figure for 1950 was only 435,958 tons.

BRAZIL

Smaller rice surplus. The exportable surplus of rice from Brazil's new harvest (March-May) is estimated at around 200 million lb. of milled rice, or about one-half the exports from the 1950-51 crop. The principal reasons for the expected decline are a reduction in rice acreage, and the December 28, 1951, decree which authorised the Ministry of Agriculture to mix as much as 12% of other grain flours, including rice, with wheat flour in order to cut wheat imports and increase the consumption of domestically produced grains.

Present prospects for the harvest of Rio Grande do Sul, Brazil's principal exporting State, are about the same as 1950-51. It is estimated that the same acreage was planted and the crop has proceeded normally. Rio Grande do Sul farmers are continuing to plant rice at the same high level, since the Federal Government is interested in rendering financial help to the Institute by (1) guaranteeing a remunerative minimum price to producers, and (2) assisting in the disposal of exportable supplies.

Exports of milled and broken rice from January to August 1951 were 278 million lb. shipped to the following countries: United Kingdom 84 (million lb.), Peru 77, British West Indies 20, Germany 18, Canada 18, Senegal 16, Bolivia 11, Colombia 6, Liberia 4, Venezuela 2, and other countries 22. Nearly 60% was exported from the State of Rio Grande do Sul and 40% from the State of Sao Paulo.

PERU

More rice grown. Peru may be able to dispense with rice imports this year. According to information from Lima, says the U.S. Department of Agriculture, this season's rice acreage is expected to be about 15% above the 117,000 acres harvested in 1951, which yielded nearly 425 million lb. of rough rice. It is thought, however, that the average per-acre yield may not be so high as in 1951 because of plantings in some new areas this season.

The 1951 production will suffice to meet the present monthly allocation for domestic consumption of 21,000,000 lb. of milled rice to the end of August, when the 1952 harvest will be completed. The extremely short crop of 1950 made it necessary to import about 140,000,000 lb. of milled rice in the 1950-51 (August to July) marketing year. Little rice has since been purchased from abroad.